COMBUSTION

EVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

March, 1946

Photo by H. R. Towse

Partly formed boiler shell section in 6000-ton press. Pressmen in asbestos suits with man on left signaling to crane operator

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Editorial

St. Lawrence Project Up Again

Hearings now in progress before a Senate Committee considering the St. Lawrence Project have thus far comprised favorable testimony by federal government officials, the New York State Power Authority, and other disciples of public power supply, and unfavorable opinions by representatives of those interests that would be adversely affected by the waterway feature. The first group see in it a boon to rural electrification and contend that it would encourage further large power-consuming industries in the northern part of New York State. The latter group, comprising representatives of New England, New York City, and Buffalo commercial bodies and the railroads, sense a large loss in business with the direct shipment of water-borne freight between the Great Lakes cities and foreign ports. They argue that such traffic, because of ice conditions, would be closed for several months of the year and would thus impose an unbalanced and unprofitable demand on existing transportation facilities. Opposition has also been voiced by the coal industry.

To date, however, very little has been heard from the power interests that might be affected and no authentic data have been offered on the power economics of the plan. After all, this is most important considering that an ultimate capacity of nearly a million kilowatts is involved at a vast expenditure of money. A study of this phase of the plan with proper allocation of fixed charges, rather than the political slogan of "cheap power," should be given full consideration in arriving at a decision on the project.

Coal Prices Jeopardized

Although the notice filed by John L. Lewis, on behalf of the United Mine Workers, was a step to conform to the legal requirements of the Smith-Connelly Act, it does not mean that a strike in the bituminous coal industry this spring is a certainty. Nevertheless, it is a threat which is likely to be carried out if negotiations with the operators fail to satisfy union demands. But, judging from past experiences, whatever the outcome, higher fuel prices to the consumer are likely to result.

The designs of most steam plants are predicated on studies of fuel costs balanced against investment costs, and uncertainty as to the former for any appreciable period makes the design problem difficult. It does, however, emphasize the necessity of attaining high efficiency.

Frequently recurrent disturbances in such a basic commodity as coal point to the desirability of negotiating longer term contracts between miners and operators than has been customary. The difficulty of doing so under present conditions is not underestimated, but consumer interests certainly warrant a greater degree of stability and deserve consideration.

PLANT ATKINSON—
High-Pressure Addition

A description of the new 600,000-lb per hr, 850-psig, 950-F steam-generating unit and its auxiliaries in the recent extension to Plant Atkinson, which increases the total electric generating capacity of the station to 180,000 kw. Performance figures are included with an expected station heat rate of close to 12,000 Btu per net kwhr.

By E. C. GASTON, Mechanical Engr.
The Commonwealth & Southern Corp.

THE installation of a third unit has been completed at Georgia Power Company's Atkinson plant. The addition of this new unit increases the capacity of the plant to 180,000 kw (name plate rating) which makes it the largest steam-generating plant on the entire Georgia Power Company system, as well as the largest generating plant (housed in a single continuous building) on the entire Southern Division of The Commonwealth & Southern Corporation inter-connected system.

The first two units in Plant Atkinson, each rated at 60,000 kw, were designed for relatively low-pressure service, the steam conditions at the turbine throttle being 425 psig, 725 F. Unit No. 1 was provided with two 375,000-lb per hr boilers, and Unit No. 2 with one boiler of 650,000 lb per hr maximum capacity. The two low-pressure units are cross-connected so that any boiler can be used to supply either of the turbines.

New High-Pressure Unit

Construction of the third unit was authorized in the spring of 1944, construction being started about the middle of that year and completed in September 1945. Studies prepared prior to the authorization of the plant extension dictated that the new unit should be designed for higher steam pressure and temperature in order to take advantage of the improved economy thus obtainable. Accordingly, it was specified that the new unit should be designed for throttle steam conditions of 850 psig, 900 F total temperature.

The following description will be confined to the layout, specifications and special design features of the boiler room equipment. Fig. 1 is an exterior view of the completed three-unit plant and indicates the relation of extension housing Unit No. 3 to the previously installed two-unit plant. Fig. 2 shows a general cross-section through the high-pressure extension.

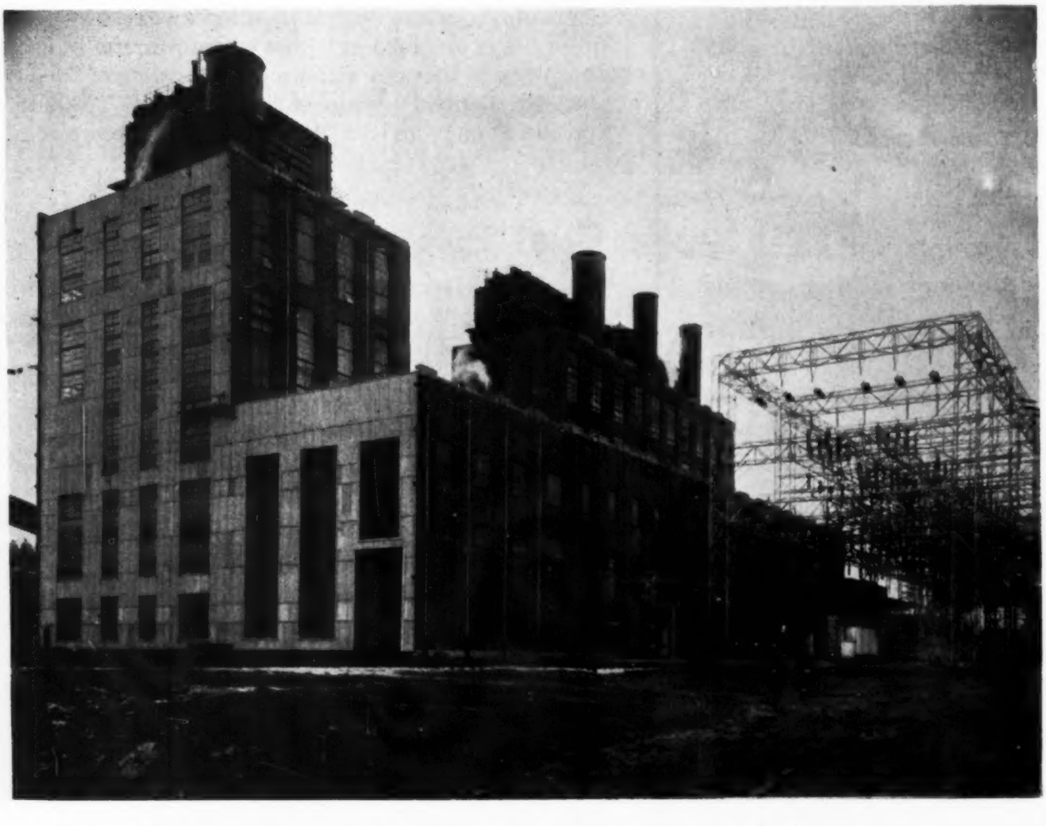


Fig. 1—Exterior view of station with latest extension in foreground

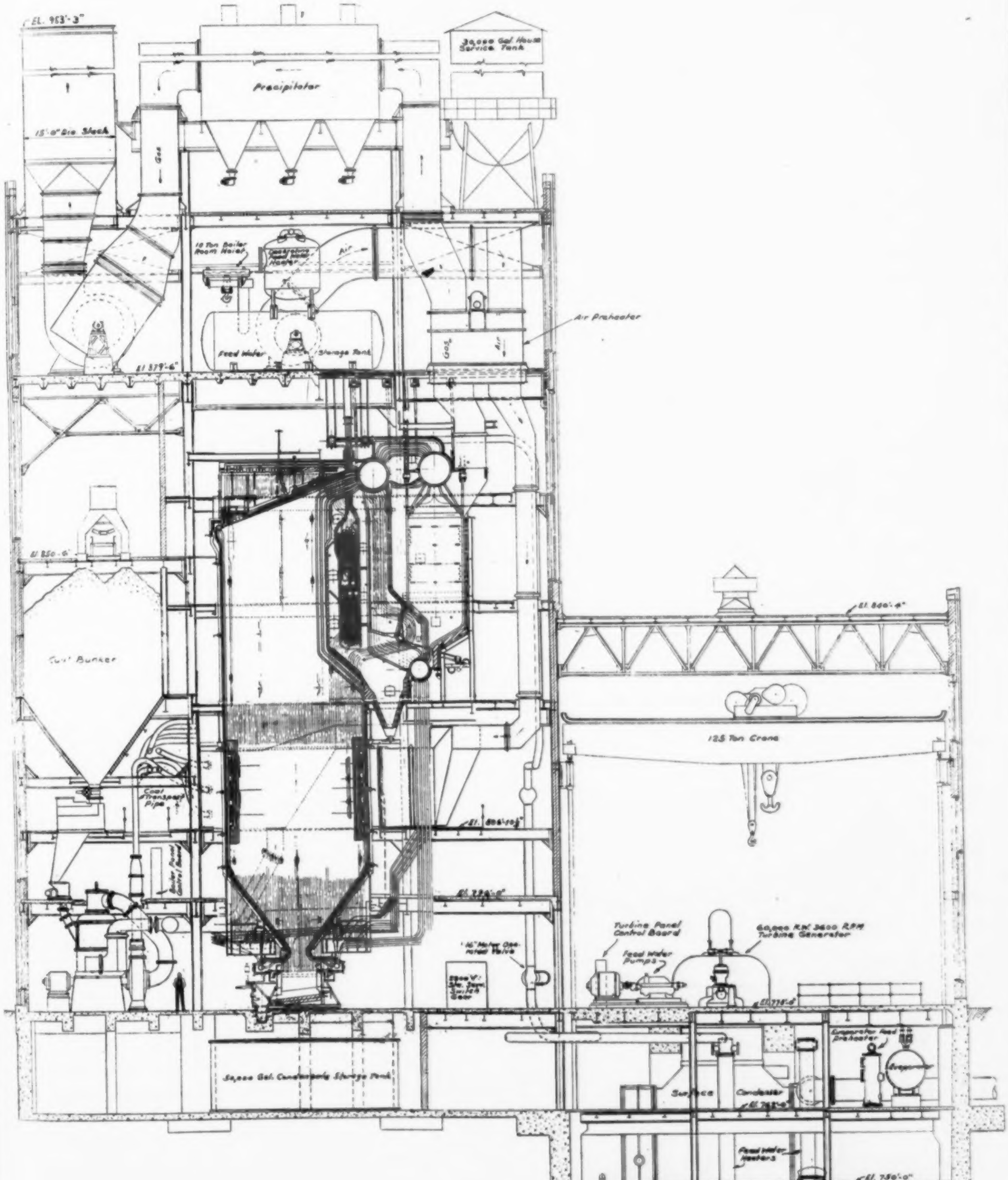


Fig. 2—Cross-section of extension including 600,000-lb per hr boiler and 60,000-kw turbine-generator

When the design of the initial plant was begun in 1929, it was contemplated that the ultimate capacity which could be installed at this site would be four 60,000-kw units. The plant layout was initiated on this basis and on the further assumption that two boilers would be installed with each 60,000-kw unit. However, when the second low-pressure (425 psi) unit was added in 1942, boiler development had reached the point where reliability very closely approached that of the turbine. In the period between 1929 and 1942, the trend in design had definitely veered from cross-drum straight-tube units to the bent-tube multiple-drum type. With the improved circulation thus obtained, which factor was also accompanied by the development of completely water-cooled furnaces and unit system of pulverized coal firing, practically all limitations on size of boiler units was removed. Therefore, when Unit No. 2 was added the original design plan was discarded and only one boiler unit was installed with it.

When Unit No. 3 was authorized it was decided to again limit the boiler capacity to a single unit. Since the original plant layout was started with the turbine room arranged so that the turbine-generators were parallel to the boiler room, the length of the turbine room was becoming too much out of proportion with the length of the boiler room. In order to correct this condition, it was necessary to develop one of the unique features of the new plant layout. Reference to Fig. 1 will show that the boiler room is not a continuous building. The three low-pressure boilers are installed in one structure, and the new high-pressure boiler is in a separate structure with a distance of approximately 97 ft between the two rooms. The space between the two boiler rooms has been utilized for machine shop and store room facilities. Also, in order to provide ease of communication between the operating floors of the two boiler rooms, an enclosed gallery has been constructed between the two separate boiler plant buildings. The coal conveyor over the top of the bunkers has also been extended across the space between the two buildings and the same tripper is used for unloading coal in both of the boiler room buildings.

Boiler and Related Equipment

The boiler is of Combustion Engineering three-drum design having a maximum continuous rated capacity of 600,000 lb of steam per hour, with steam leaving the superheater at 875 psig pressure and 860 F total temperature. The pressure parts of the boiler are designed for 975 psig. It will be noted that there is a differential of 100 lb between the superheater outlet pressure and the boiler design pressure which is also the safety valve setting pressure. This provides a comfortable operating margin which saves operation of safety valve equipment, as might occur with relatively minor load changes if a lesser differential were provided.

The furnace is completely water-cooled and the unit is equipped with an economizer and air heater. The heating surfaces are as follows:

Boiler, 18,650 sq ft
Superheater, 14,375 sq ft
Water walls, 9789 sq ft
Economizer, 15,000 sq ft
Air heater, 49,680 sq ft

The superheater contains ninety-four elements, each consisting of $2^1/_8$ in. O.D. tubes on 3.57-in. centers. The last two loops of each element are chrome molybdenum steel, the next seven loops carbon molybdenum steel, and the remaining elements plain carbon steel. The superheater is all-welded to both inlet and outlet headers, the only rolled tubes being the connections to the steam drum on the drum end of the supply tubes to the inlet header. It is equipped with a bypass damper, located near the bottom pass, and arranged to maintain a constant steam temperature of 860 F at the superheater outlet for all loads from 360,000 lb to 600,000 lb per hour.

The economizer is of all-welded construction. It is 33

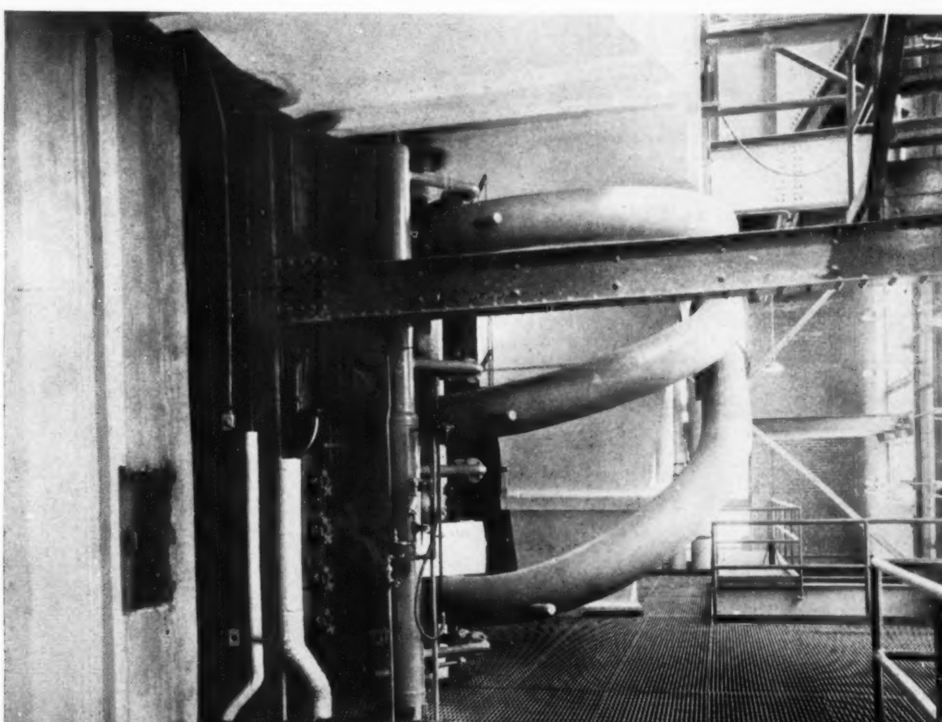


Fig. 3—View of left rear corner of unit at firing level, showing coal-feeder pipes pulverized-coal burners and gas supply lines

tubes wide, 16 tubes high, all of 2-in. O.D. spaced on $3^{1}/_{8}$-in. centers in the horizontal plane and 5-in. centers in the vertical plane. The design and arrangement produce parallel flow of steam and gas.

Two air heaters of the Ljungstrom regenerative type are provided. These have motor-operated soot blowers.

The boiler is served by three C-E Raymond bowl mills each driven by a 300-hp, 900-rpm constant-speed motor.

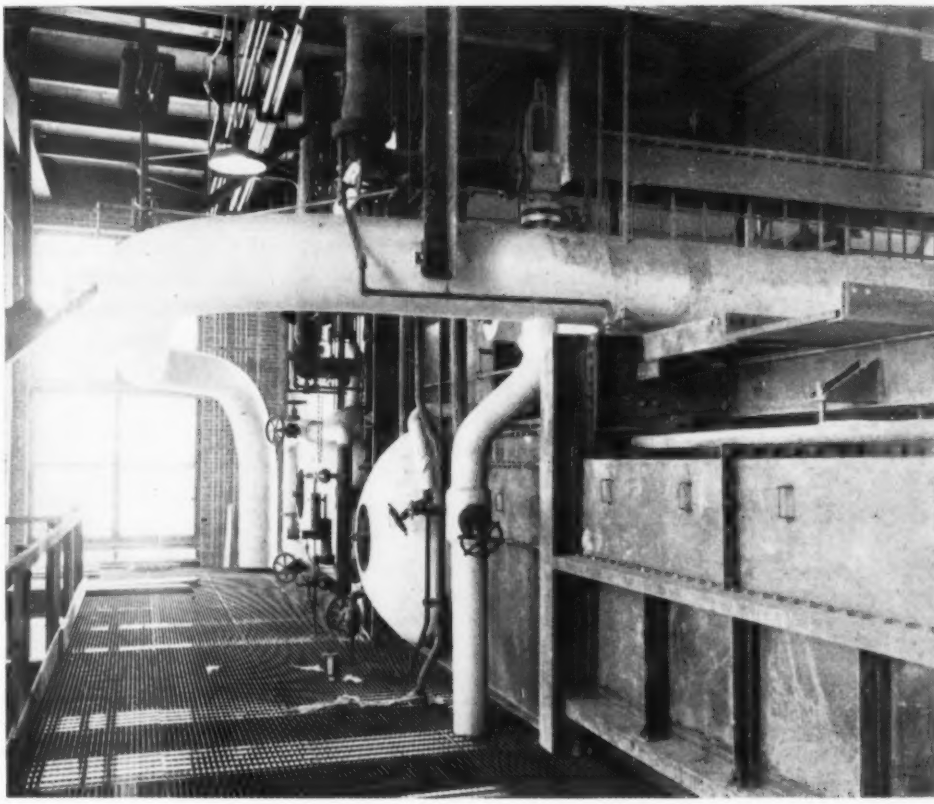


Fig. 4—End of boiler drums showing outlet header, steam lead and water column

Each mill has a maximum capacity of 20,800 lb of coal per hour, when pulverizing coal having a grindability of 35 per cent (Hardgrove Scale), 10 per cent moisture, under which maximum conditions the guaranteed fineness is not less than 70 per cent through a 200-mesh screen. One feeder is installed per mill, each feeder being equipped with a Stirling variable-speed mechanical drive. The flow of coal is from the bunkers through a Richardson scale, through the feeders to the mills. The coal piping between the mill exhausters and the burners is arranged for high velocity horizontal lines.

The furnace is tangentially fired, there are three burners per corner or a total of twelve 10-in. burners in all. In addition, each is equipped with orifices for burning natural gas when such fuel is available. The coal burners are of the tilting type, adjustable for 20-deg range up or down from the horizontal to afford adjustment of furnace exit gas temperature and thus aid in controlling superheat and slag. Fig. 3 is a view of one group of burners, showing the three 10-in. pulverized coal feed pipes to the three burners. In front of the coal pipes and burners is the main gas header with the smaller gas supply lines taking off to the six gas burners, there being six gas burners per corner or twenty-four per boiler.

The furnace is completely water-cooled and designed for dry bottom operation. The heat release in the furnace at rated capacity of 600,000 lb per hr is 21,000 Btu per cu ft per hour.

Boiler Performance and Arrangement

The performance of the boiler unit, at 600,000 lb per hr rating, is guaranteed as follows:

Superheater outlet pressure 875 psig
Superheater outlet temperature 860 F
Total draft loss (boiler, superheater, economizer and air heater), 10.36 in. of water; air pressure loss between forced-draft fan outlet and burners, 8.05 in. of water
Pressure drop through superheater, 63.0 psi
Total overall efficiency, 87.55 per cent

This boiler is a duplicate of another 600,000-lb per hr unit installed in 1944 for the Alabama Power Company at its Gorgas Steam Plant. In order to save design time and engineering costs, particularly with reference to structural steel and boiler building, the floor levels, platforms, etc., are identical in the two plants. This procedure also speeded up the purchase of steel and other vital materials. However, to accomplish the main purpose it was necessary to compromise in some parts of the layout. In order to utilize existing coal-conveying equipment, the top of the raw coal bunker was fixed by the top of the bunkers in the old low-pressure plant. To obtain the required minimum coal bunker capacity of 750 tons the new boiler room was made 8 ft wider than the old one. Likewise, the headroom between the bottom of the bunker and the pulverizer room was limited to a lesser height than would ordinarily have been provided. Due to their size and height, the tops of the three pulverizers extend through the operating floor at Elev. 796. However, the area thus affected is in front of and sufficiently distant from the boiler and from the operating board to cause no concern. In fact, the compact arrangement of bunker, scales, feeders and mills may prove to be an operating and maintenance advantage.

Draft Fans and Dust Collector

The draft-fan equipment is of Sturtevant design. The forced-draft fan has a capacity of 210,000 cfm air at 100 F, against 12.5-in. water static pressure. This fan operates at 885 rpm and is driven by a 600-hp constant-speed motor. Control of air requirements is obtained

by automatic adjustments of vanes installed in the fan inlet. Only one motor drive is installed on this fan. In order to provide satisfactory air control during starting up and extreme light load operating conditions, remote manual control is installed on the discharge damper. This permits closing down on this damper, which results in a corresponding opening up of the inlet vanes. This is necessary in order to avoid the difficulty in controlling air which would result if the vanes were allowed to position themselves in too nearly a closed position.

The induced-draft fan has a rated capacity of 350,000 cfm gas at 375 F against 16.0-in. water static pressure. The full load speed of the fan is 710 rpm. The fan drive consists of a single motor. However, in order to provide control, the motor is of variable-speed design and equipped with a thirteen-point step controller which

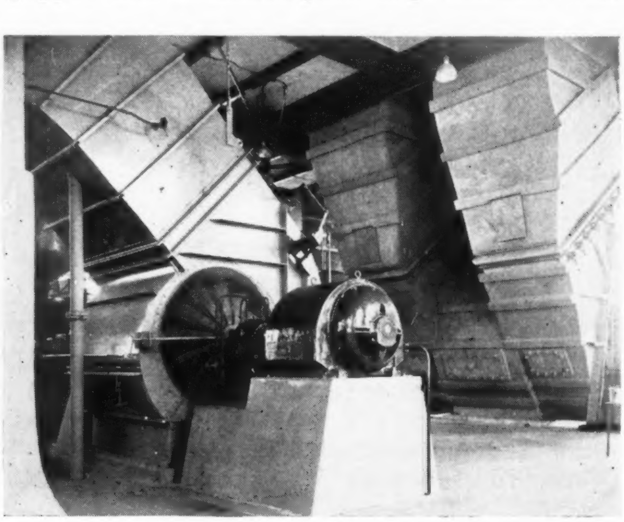


Fig. 5—Fan floor with forced-draft fan in foreground and induced-draft fan in background.

provides equal increments of speed from a minimum of 350 rpm to 710 rpm. Automatic combustion control is connected to the inlet damper of the fan in order to control the furnace pressure at each set speed of the fan.

Fig. 5 is a view on the fan floor showing the forced-draft fan in the foreground and the induced-draft fan in the background.

In order to eliminate the fly-ash nuisance to areas surrounding the plant and, at the same time, to reduce fan maintenance due to fly ash erosion, a dust collector is installed on the roof of the plant between the air heater outlet and the induced-draft fan inlet. This is a Cottrell electrical precipitator. It is a two-unit collector each unit containing 27 ducts, $8\frac{3}{4}$ in. wide 17 ft 6 in. deep and 18 ft long. The two-unit collector unit will handle a maximum of 350,000 cfm gas and is guaranteed to produce a collection efficiency of 90 per cent, or better.

The presence of two air heaters with only one forced- and one induced-draft fan; the necessity for providing space on the same floor for the deaerating heater, the precipitator substation and the induced-draft fan variable-speed-motor controller, as well as the required arrangement of ductwork to and from the precipitator, all resulted in a compact but noteworthy arrangement of equipment on the fan floor at Elev. 879 ft 6 in. The forced-draft fan is located over the center of the boiler and between the induced-draft fan and the air heaters. The discharge duct from the forced-draft fan is carried between the gas outlet ducts from the air heater to the precipitator. After clearing the gas ducts, the air duct then splits and discharges to each air heater. An adjustable splitter in the main duct makes it possible to equalize the air delivered to each of the heaters. The draft loss across one of the heaters is used as a measure of the combustion air requirements. To insure accurate performance of the automatic control equipment as well as to stabilize gas and air flows through the furnace and boiler, it is essential that the work done by each of the two heaters be as nearly equalized as possible under all load conditions.

Control Boards Separately Located

With further reference to the boiler room equipment layout, it will be noted that the boiler control board is located at Elev. 796 ft. In order to avoid the necessity for a separate water-tending station at the top of the boiler, the unit is equipped with remote water-level indicating and recording equipment all of which has been brought down to the operating floor level. Fig. 4 shows the arrangement of the Reliance water column on the left-hand side of the boiler. The indicator for this column is located on the boiler control board. A Diamond bi-color gage is located on the opposite side of the boiler, the mirror being at the operating floor within easy visibility of the boiler operator. The large pipe in the foreground of Fig. 4 is a 12-in. steam lead; a similar line leaves the opposite end of the superheater outlet header. The two 12-in. lines join at the rear of the boiler into a 16-in. line leading to the turbine throttle.

No attempt has been made to combine the boiler room and turbine room control stations, a separate control board being located in the turbine room for the use of that operator. This plant is also arranged with a switch room which is separate from both the turbine and the boiler rooms. The electrical control of all three units as well as of all outgoing feeder lines is handled from this separate room.

Although the deaerating heater and the condensate storage tank are not primarily boiler room equipment, the location and arrangement of these items of equipment are worth mentioning. The deaerating heater is located on the fan floor of the boiler room in order to provide the maximum possible static head on the suction of the boiler feed pumps which pumps are installed on the main operating floor of the turbine room. The condensate storage tank is located underneath the boiler and has 50,000-gal storage capacity which represents more than twice the total water capacity of the boiler. This tank is of all-steel construction and is independent of the concrete foundations. In the old plant, the same space was utilized for condensate storage but the tank was constructed of concrete, the walls of which were worked in with the substructure foundations. This did not prove to be satisfactory since it resulted in pollution of the condensate due to contact with the concrete.

The third unit in this plant is now in regular and continuous operation. Performance of the plant to date has been highly satisfactory with respect to convenience of operation as well as overall economy. The original design contemplated an average full load station economy of approximately 12,500 Btu per net kwhr, but it is likely that the actual economy will be nearer 12,000 Btu per net kwhr.

The Future of Nuclear Power

By JOHN ARCHIBALD WHEELER

Associate Professor of Physics, Princeton University

Professor Wheeler, a recognized authority on nuclear physics who was actively associated with the Hanford phase of the atomic bomb project, discussed possibilities of its peacetime application to power production before the Metropolitan Section, A.S.M.E. on January 30, 1946. In the following excerpts from his talk the basic principles are reviewed and some of the problems of the future nuclear energy plant are pointed out. Chief among these is the problem of shielding which would limit the economic application to large plants, probably 100,000 kw and above—Editor.

THE Hanford plant was not built to generate nuclear energy. Its purpose was to synthesize a new chemical substance, plutonium, element 94, to make atomic bombs, and the production of heat in the reaction was a positive drawback in the program to make as much plutonium as possible. However, in the nuclear energy plant of the future the liberation of energy in the form of heat or otherwise will be the primary objective and the production of plutonium or other substances subject to nuclear fission will be secondary. But the most difficult problems will be engineering problems: first, to transfer heat from the chain-reacting structure, the so-called pile, to a cooling fluid; and second, to convert this heat into usable energy. The problems of nuclear physics which enter into the design of the power-producing pile of the future have in principle been solved.

Industrial men and scientists connected with the uranium project agree that it is only a question of time before we shall have an industrial technology of nuclear energy which can pay its own way. And that time interval will depend most of all upon the engineering talent which is applied to the solution.

Similar to Hanford in Six Ways

Nuclear physics tells us that this future power plant will be quite similar to the present Hanford piles in six important ways.

First of all, the heat-releasing reaction will be fission, the division of a heavy atomic nucleus into two parts of approximately equal mass. We can exclude from consideration other transformations such as the reactions of lighter atomic nuclei which provide the heat of stars. These reactions occur at a significant rate only at temperatures between one and fifty million degrees. Nuclear fission, on the other hand, requires for its production, not high temperatures, but only bombardment of the nucleus in question by the elementary particle known under the name of neutron. Not only is one neutron sufficient to produce fission, but the act of fission produces, in turn, several new neutrons, each capable of producing a further fission process, provided that more nuclei are available which are susceptible to nuclear fission.

This requirement brings us to the second feature of the present chain-reacting units which will be preserved in the piles of the future. There will be required, as source of energy, a substance which undergoes fission with high probability when struck by a neutron. Only a few nuclear species satisfy this condition. They are all comparable in atomic weight to uranium, or heavier than it. The two most prominent examples are plutonium-239, the most important variety of the new and 94th chemical element, and uranium-235, the variety of nucleus which is present to one part in 140 in ordinary uranium. Both nuclear species play an important part in the Hanford piles. The U-235 undergoes fission and thus maintains the nuclear chain reaction. Most of the extra neutrons not needed for continuance of the chain reaction are used in synthesizing the new fissionable element, plutonium. The pile of the future must operate by fission of one or other of these two substances or of some nuclear species very near to these two in the periodic system of the elements.

Unfortunately, none of the desired fissionable species of nuclei exists in nature in anything but insignificant traces, except U-235. Furthermore, the task of separating U-235 from ordinary uranium is difficult and expensive. Consequently, it is reasonable to ask of the pile of the future a third feature, that it should synthesize by a suitable side reaction as much as possible of the fissionable material which is burned up during operation. Here again the Hanford piles point the way. At the same time that their operation burns up the one fissionable material, U-235, it creates the new and equally desirable fissionable species, Pu-239.

In partial explanation, the process of synthesis starts with the very abundant but otherwise useless nuclear species, U-238. This species, by capture of a neutron and a resultant sequence of changes, is transformed into the wanted Pu-239.

One may ask, if the heat given off in this reaction was such a source of engineering difficulty in the war program, why bother to go to all the trouble to destroy one perfectly good bomb-making material in the course of making another one? The answer is simple. It was much easier to separate out from the original element, uranium, the new and chemically distinct element, plutonium, than it was to separate two forms of uranium from each other. The whole point of the Hanford program was to avoid the problem of separation of two different species of the same chemical element and to replace it by the problem of chemical separation of two distinct elements. It paid to do this despite the heat transfer difficulties which were encountered and the fact that all the heat was thrown away. However, in the pile of the future, where the heat energy will be of primary interest, con-

siderations of economy will give the same incentive we had to produce fissionable material from an otherwise relatively useless raw material such as the abundant U-238.

New Fissionable Material Must Be Added

In future attempts to accomplish this regeneration process, there will be one or another of two possible outcomes. It may be that each day of operation of the pile of the future will burn up, let us say, 1 kg of the original fissionable material and regenerate out of U-238 or similar inert material possibly only 0.9 kg of new fissionable material such as plutonium. In this case the plant can continue operation only if there is supplied from outside each day 0.1 kg of new fissionable material. This requirement will prevent atomic energy from becoming as cheap as one should like to have it.

The other possible outcome is more favorable to economy of raw materials. In every day of operation in which 1 kg of fissionable material is destroyed, we synthesize from an inert substance more than 1 kg of new fissionable material, say, for example, 1.1 kg. In this case 1 kg of the new product is left in the plant to make up for the losses of the day and the other 0.1 kg is removed to help start up a new pile; or, if necessary, to help make atomic bombs. If this can be achieved, there is no need to supply new fissionable material to the plant from the outside, except to get it started. After it is in operation we could even feed it, as raw material, uranium from which all of the active constituent, U-235, has been extracted, although it would be cheaper to use natural uranium. The plant itself will convert the inactive uranium to fissionable material for use in the chain-reaction. Evidently it is necessary only to design a plant with sufficiently good regeneration characteristics in order to use for power purposes all of the uranium, not merely the rare constituent U-235.

However good the regeneration characteristics of the future power plant, a continuous supply of raw material must be available. This requirement leads to the fourth point of similarity with the Hanford chain-reacting units. It will be necessary in the future, as in the past, to use for raw material either uranium itself or possibly some other element of comparable abundance, but with a neighboring or higher position in the periodic table of the elements. The only such substance that exists in nature is thorium, an element apparently somewhat more abundant than uranium. Consequently, the pile of the future will be expected to use as a source of energy either uranium or possibly thorium.

Chemical Plant as an Adjunct

There is a fifth requirement of the future nuclear power plant which is not so obvious as those that have gone before. Associated with the power unit there should be a chemical plant for the treatment both of the raw material and of the fissionable material after they have been exposed in the pile. We will expect different locations to be chosen for these two materials to get the best results. But as time goes on fissionable material will be synthesized within the relatively inert raw material. If this fissionable substance is allowed to stay where it is, it will eventually be struck by a neutron and be caused to split; but to split at a point in the pile where the neutrons which it gives off will not be used with full effectiveness. To avoid this loss of efficiency, which might be serious, we must expect to have to withdraw the raw material periodically from the unit and extract from it the newly synthesized element. The two components that result from this chemical separation process will then be sent back to their proper places in the pile, the raw material to one location, the fissionable material to another.

This is not the only task which the chemical plant will have to perform. The fissionable material will also experience changes calling for its reprocessing. The products of nuclear fission, elements of medium atomic weight like barium, lanthanum, xenon, rubidium, selenium, tellurium, silver, ruthenium, will accumulate and poison the chain-reaction by absorbing the neutrons which are needed for more productive purposes. Consequently, these by-products of the reaction will have to be removed from time to time from the fissionable material, whether this material be U-235, Pu-239 or something else.

Of course, the separation plant of the Hanford pile does only a part of what is demanded of the separation plant of the future. It only withdraws from the working material the plutonium required for atomic bombs. It was designed to produce plutonium by the most straightforward possible means, with no attempt to serve as a power plant. Consequently, it does not need to prepare the working material, uranium, for reintroduction into the unit.

Shielding Problem

The sixth and last major point of resemblance between the future plant and the Hanford pile is the requirement of protection of human beings from radioactive radiations Not only does the act of fission liberate fast and penetrating neutrons, but it also releases electromagnetic radiations having the same character as X-rays and even greater piercing power. These so-called gamma rays, together with the neutrons coming from a pile in full production, near such a reactor have an intensity more than a million times as great as can be tolerated biologically by the human organism. Therefore, it is necessary to surround the pile with a shield which will cut down the intensity of these radiations to a negligible level. One can imagine the difficulties in obtaining complete protection when it is considered that there must be openings in the shield for the entrance and discharge of the cooling fluid and for the insertion and the removal of uranium or other working material before and after irradiation. Happily, these structural problems were solved at the Columbia River plants in a very satisfactory way.

However, the required shielding weighs a great deal. Even for a unit generating as little as 100 kw the shielding would have a thickness of a number of feet and weighs in the order of 50 tons. Unfortunately, there is no trick at our disposal to overcome this difficulty. The principles of shielding are simple and straightforward. What counts essentially is the product of the thickness and the density of the protective material. This means that even with the densest practical materials there is a minimum required thickness for the shield. It might just be possible to carry such a shield through existing railway tunnels on a locomotive driven by nuclear power, but the prospects for train propulsion are not bright. Atomic power appears to be quite out of the

picture for automobiles. The same conclusion applies also to airplanes, at least until their weight-carrying capacity reaches ten to a hundred times its present figure. On the other hand, it is quite in order to count on nuclear energy for driving ships, or for running a stationary electric power plant. In neither application does a heavy shield cause too much difficulty. And fortunately, the required weight of the protective material does not increase greatly with power level. Consider a shield thick enough to reduce to biologically acceptable intensity radiations from a pile which in the absence of shielding would be a million (10^6) times too intense. Increase the power output of this pile tenfold, so that the radiation is ten million (10^7) times the acceptable level. Then it is only necessary to increase the thickness of the shield in the ratio of seven to six, or 17 per cent, to shield the ten times more active pile.

Some emission of radiations continues even after the chain-reaction is brought to a halt. Some of the products of nuclear fission, elements of medium atomic weight, are radioactive when formed. These active materials are present in the irradiated uranium which is discharged from the Columbia River piles, and therefore in the uranium which is received by the chemical separation plant at Hanford. What is true of this separation plant will be true of the chemical plant associated with all future piles; hence shielding is indispensable. To give an impression of the magnitude of the shielding problem, it may be mentioned that there were poured at Hanford 780,000 cu yds of concrete. Of course, this amount of material was distributed over several plants, and only a part of it went for shielding purposes.

Applicable Only to Large Power Plants

The moral to be drawn from this discussion is that an atomic power unit is not a little gadget that one can screw to the handlebar of a bicycle, but that it really involves a sizable industrial development. The magnitude of even a single plant is necessarily so great that it may possibly not be economically feasible unless it is designed to produce at least as much as perhaps 100,000 kw of power.

The foregoing reviews briefly the six features common to present and future plants. The reaction is fission; there must be present a basic material to undergo fission; the pile, however, must produce new fissionable material; for this purpose the raw material will be uranium or possibly thorium; along with this a chemical separation plant is required; finally, heavy shielding is necessary.

With these broad features sketched in, it is easy to complete the picture of the pile of the future. Nothing has been said about cooling fluid, assuming its existence implied by the term "power plant." In the Hanford piles the cooling fluid is water; in the future power plant this fluid will be some substance capable of going to much higher temperatures than water without requiring very high pressures. High pressures would require heavy piping; but every foreign material introduced into the pile absorbs neutrons and makes it that much more difficult to run the unit efficiently. In contrast to the pressure, the temperature of the pile is a matter of relative indifference from the point of view of the nuclear chain-reaction. It matters little to the fission fragments whether the temperature of the uranium is a few hundreds of degrees or more than a thousand degrees, for their own instantaneous energy at the moment of production is equivalent to more than a billion degrees. It will therefore be reasonable to operate at as high a temperature as the materials of construction will stand, and gain all the thermodynamic efficiency possible in the power plant. The cooling fluid, whatever it is, will then be led out to a heat exchanger. There its energy will be turned over to water or mercury or some other substance capable of driving a turbine or other prime mover. That is the power plant of the future.

Adequate Control Vital

A great deal has been said about the use of active substances without adequate realization of the hazards involved. The extraordinary health and safety record of the plutonium project has drawn attention away from the difficulties which were encountered and which were solved to guarantee the safety of all the workers on the plutonium project. The problems of adequate control of the use of radioactive substances in the future appear too great to be handled on a merely voluntary basis. In the future it may very well be necessary to have all chemists who deal with radioactive materials specially trained in regard to safety precautions, and licensed and bonded to the state or national government.

The uses of radioactive substances, despite their importance, require relatively small amounts of material. It cannot be expected that the radioactive business will be one with a large income. This business will be the tail which is wagged by the power plant dog, not the other way around. The power plant must be counted upon to pay its own way as a power plant, except as it might serve as the source of bomb-making materials.

Much has been said about the destructive power of the atomic bomb. The discussions, however, tend to give the false impression that it is only necessary to have a certain stock of these bombs on hand to stop future transgressors. This conclusion may be right in some cases, but if there is anything which has been shown by the history of the last two wars, it is that one cannot count on a stockpile of anything to stop the aggressors who are really important. What is required is productive capacity and know-how; and productive capacity means big atomic power plants.

Our true security lies not in secrecy, but in a strong industrial development of nuclear energy.

I emphasize this point because some of the legislation now under consideration in Washington would make it practically impossible for any industrial concern to enter the field of nuclear power generation. I am quite in sympathy with the conclusion that the Government must have control over all fissionable materials. That is an obvious condition for all security. But I am afraid that many are now overlooking an equally obvious conditon for our security: the development of the nuclear industry. The Government cannot do this at all satisfactorily. It is not an engineering concern. Every dollar spent by the Government in encouraging industry to enter this new field will be worth ten dollars spent by the Government trying to do it itself. We cannot expect it to have all the know-how of drawing aluminum tubing, smelting uranium metal, or manufacturing graphite. We must open the new field to all qualified industries and promote a healthy competitive development. That is the way our security lies.

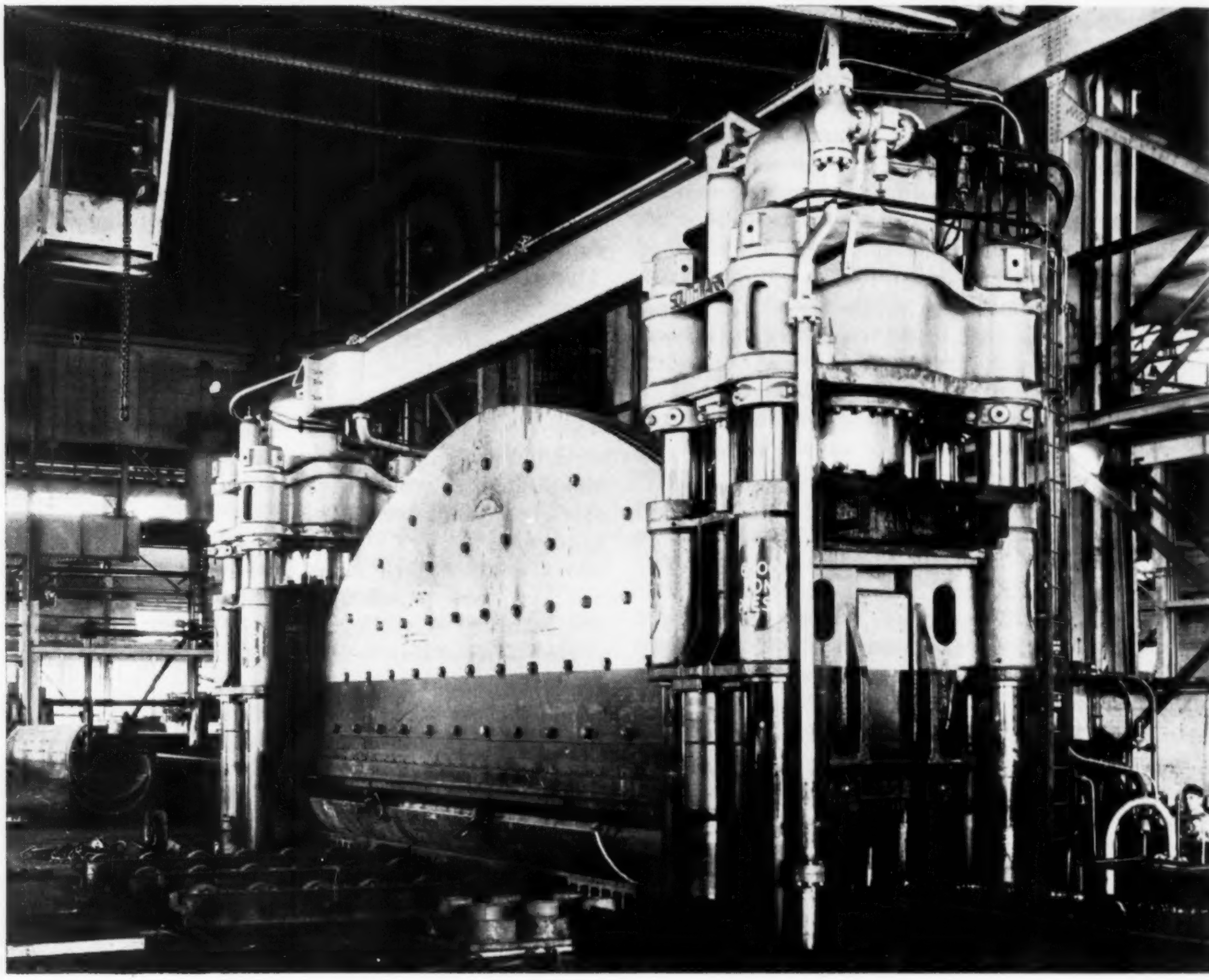


Fig. 1—6000-ton hydraulic press with shell section in dies. Press operator at lower right and crane operator at upper left

FABRICATION OF BOILER DRUMS
Part 1—Forming

This is the first of a series of articles to appear in COMBUSTION describing the fabrication of boiler drums. Subsequent articles will be devoted to welding, testing and finishing.

By H. R. TOWSE

Combustion Engineering Company, Inc.

(*Photographs by Author*)

THE fabrication of boiler drums is a complex, spectacular undertaking involving millions of dollars worth of buildings and equipment for handling, processing and testing as well as the skill and know-how of thousands of men. In addition to the men, materials and property required by the actual manufacture, a modern boiler drum represents the investment of much time and money in research, testing and checking of operation to the end that the safe, dependable and efficient performance of steam-generating units may be assured. The advances made in metallurgy and welding technique have probably been the outstanding factors in the fabrication of boiler drums as we know them today.

In this article will be described the normal sequence of operations in the forming of boiler plate in the Chattanooga plant of Combustion Engineering Company, Inc. During the course of more than half a century, in which boiler building has advanced from a more or less crude procedure to a highly specialized industry requiring great accuracy of manufacture, this plant has been a leader in developing means and methods to keep pace with the ever-increasing requirements of pressure and

temperature in stationary and marine steam-generating practice.

The first boiler drum to be fabricated by fusion welding and stamped with the Boiler Code Symbol of The American Society of Mechanical Engineers was built in these shops. In the intervening years, thousands of welded boiler drums and pressure vessels of all types and sizes have been fabricated here. These include shell plate up to $5^1/_4$ in. thick and boiler drums weighing over 80 tons.

Upon the delivery of the boiler plate from the rolling mill, it is inspected for surface flaws during the unloading by experienced shop men who also check the size and thickness. The mill test reports of physical and metallurgical properties are accepted unless the shop inspector has reason to doubt a particular piece. In such cases, samples are tested in the shop laboratory before acceptance.

All plate used in the manufacture of boiler drums must conform to the specifications of the Code for Power Boilers of The American Society of Mechanical Engineers. In this article, the plate used in a boiler drum will be considered under the classifications of shell plate, head plate and plate for reinforcing pads. The formation of plate used in drum heads is carried on in one part of the shop while the shell plates are formed in another area.

The heavier plates are formed in a press. Before forming, the ends are trimmed in a milling planer and the edges are ground to a small radius so as to minimize the danger of cracking when they are bent. The side edges of the plates are not machined until after the forming operation. If a plate is from $1^1/_2$ to 2 in. thick, it is stress-relieved in a furnace and then allowed to cool slowly to room temperature, after which it is ready for cold-forming to final curvature in a hydraulic press. If it is over 2 in. thick, the Boiler Code requires it to be normalized before it is formed. Normalizing the plate consists of placing it in a furnace and heating to 1600 to 1750 F, depending on the composition of the steel, and holding the temperature for $^3/_4$ of an hour per inch of thickness. Upon completion of the normalizing operation, the plate is removed from the car-type furnace and

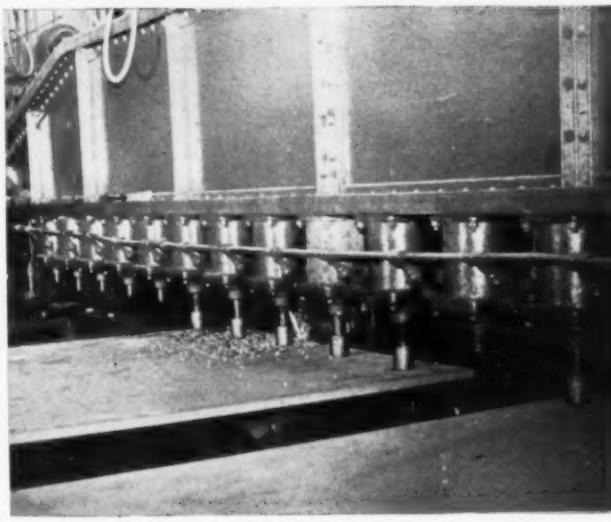


Fig. 3—Trimming ends of shell plate in milling planer. Plate is held in position by hydraulic clamps

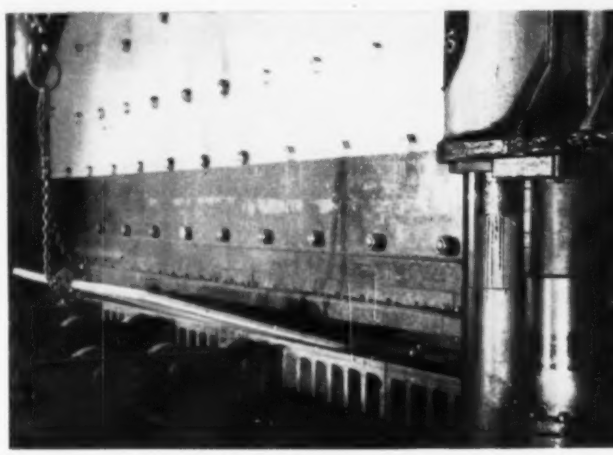


Fig. 4—Start of forming operation. Edge is crimped in dies and then the plate is moved through the press to crimp the other edge

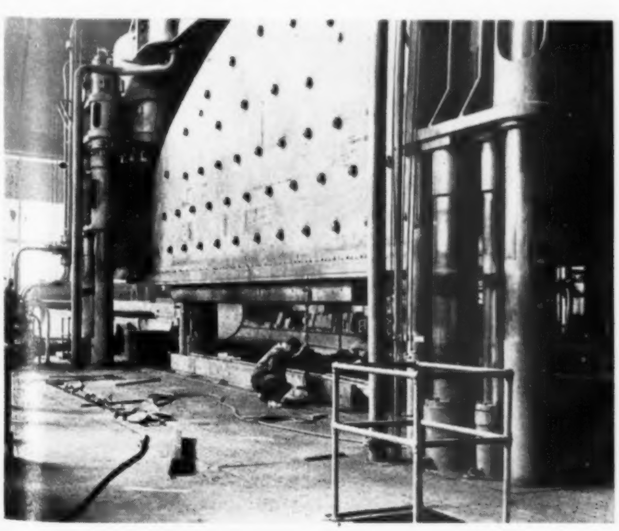


Fig. 2—Press operator checking dies of 6000-ton press. Controls are at far end of press at extreme left

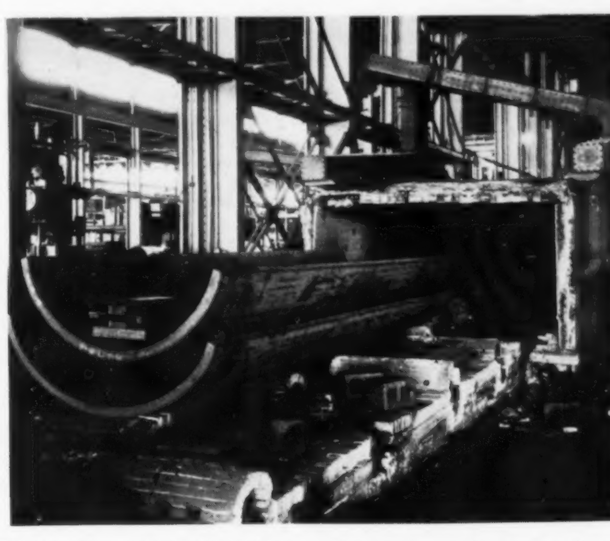


Fig. 5—Formed shell sections after stress-relieving in heat-treating furnace. Test plates shown in upper shell will go to the laboratory

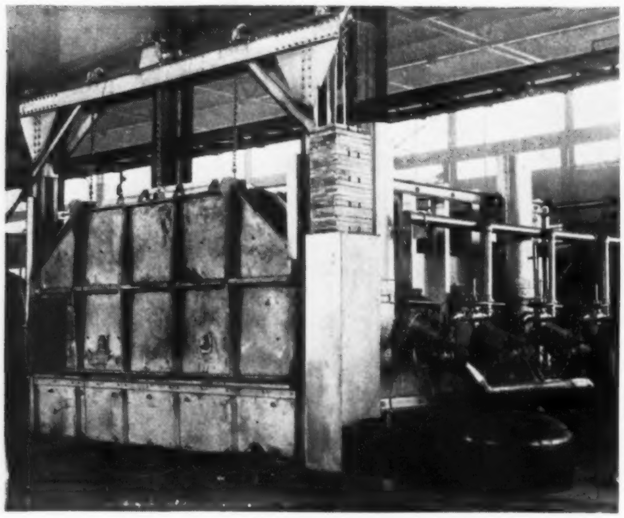


Fig. 6—Furnace in which head plates are heated

Fig. 7—Circular head plate is removed from furnace and placed on die of hydraulic head press

is picked up by the crane and carried to the press, where advantage is taken of the normalizing heat for hot-forming.

The crane is unusual, being a double, adjustable arrangement with a capacity of 30 tons. Each half, consisting of two beams, carries a hook and may be separated from the other half—so as to accommodate various lengths of plates. One operator controls both sections which may be moved separately or in unison and his cab may be moved to any point along the rear half of the crane so as to be directly above the work.

Pressmen in asbestos suits and helmet shields maneuver the hot plate into position, aided by the crane operator. The procedure is superintended by the press foreman who directs the handling of the plate and the operation of the press by unmistakable hand signals. In addition to the foreman, the press crew consists of the crane operator, a press operator and six pressmen.

Plate Forming

When the hot plate reaches the press, one edge is crimped. Then the plate is moved through the press and after removal of scale by a blast of compressed air, the other edge is crimped. Forming proceeds from the edges toward the center. The crane aids in shifting the plate which is also moved by manipulating rams which have a vertical and sidewise movement through the lower die. After each downward stroke of the press beam, the curvature is checked with a templet. Downward travel is limited by shims under each end of the beam. Hot-forming is stopped before the final curvature is reached and the shell section is returned to the furnace for stress-relieving, after which it is allowed to cool slowly to room temperature before final cold-forming.

All final forming of shell sections is done cold. If, during cold-forming, the limit of the allowable elongation of the outside fibers is approached, the shell section is subjected to intermediate stress-relief and cooling to room temperature before further cold-forming. Elongation is a function of plate thickness and radius of curvature and the procedure may be varied to suit the conditions. In addition to allowing accurate measurement of

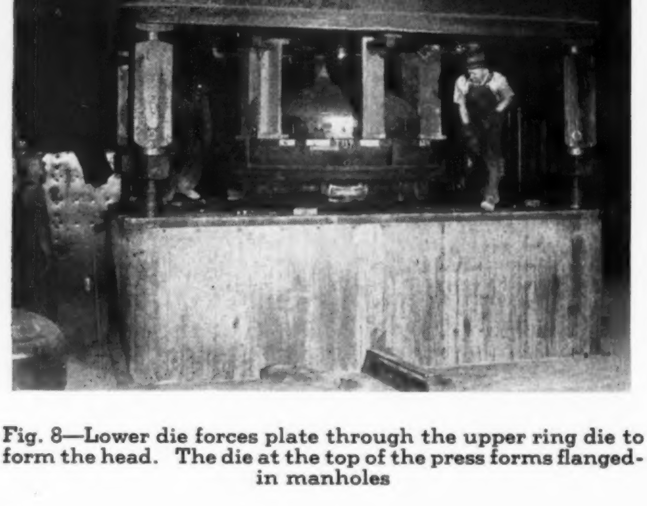


Fig. 8—Lower die forces plate through the upper ring die to form the head. The die at the top of the press forms flanged-in manholes

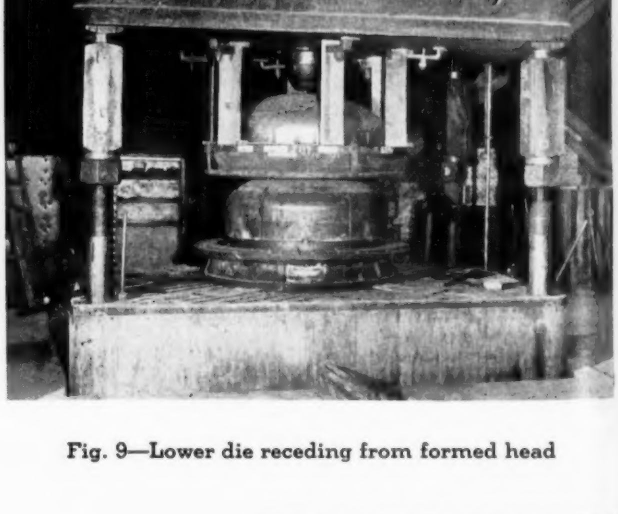


Fig. 9—Lower die receding from formed head

the finished work, final cold-forming provides an excellent test of the steel.

The press used in these forming operations was designed by C-E engineers and is the largest and most powerful of its type so far built and has formed the heaviest and thickest boiler plate in use today. The maximum thickness capable of being formed in this press is not known but it is believed to be considerably greater than any requirements of modern pressure vessels. Some idea of the speed of this press may be gained from the fact that in 40 minutes from the time a plate 25 ft $\times$ 10 ft $\times$ $3^1/_{16}$ in. thick was removed from the normalizing furnace, the plate was ready for stress-relief and final cold-forming and a second plate of the same size was on its way to the press. The actual hot-forming operation took about twenty minutes.

The power for accomplishing this task is derived from two large hydraulic cylinders connected by a built-up top beam weighing about 250 tons. There is a similar bottom beam beneath the floor. The top beam has sliding shoes to equalize the movement and to prevent binding. A crossover pipe equalizes the pressure between the two main cylinders. The force applied by the beam is 1500 tons per cylinder without the use of an intensifier which increases the force to 3000 tons per cylinder or 6000 tons total. The overall height is 49 ft with 27 ft above the operating floor. The clearance between end posts is over 40 ft. The weight of the entire unit is slightly over 2,000,000 lb.

Plate Rolling

Light plates are trimmed for welding on all four edges in a specially designed planer, after which the longitudinal edges are crimped in a 600-ton press or in dies in the bending rolls which are used to cold-roll the plate to final cylindrical form. Rolled shells may be made from one plate if the entire shell is of one thickness, or from two plates if the boiler tube hole section is thicker than the opposite section. Rolling, clockwise and counter-clockwise, continues until the shell section is true to templet. Since no stress-relief is required at this stage, the sections pass on to the fit-up and welding operations.

While the shell sections are being formed, operations on the boiler drum heads are going on in another part of the shop where, after inspection and layout, the procedure followed on the circular head plates depends on whether they have flanged-in manholes or reinforced manholes. The latter are heated to normalizing temperature in a special furnace and treated in the same man-

Fig. 10—Drum head is removed by crane

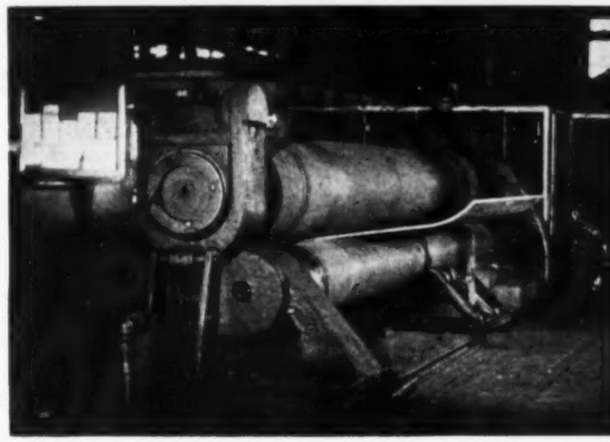


Fig. 11—Plate being cold-rolled after crimping longitudinal edges in dies

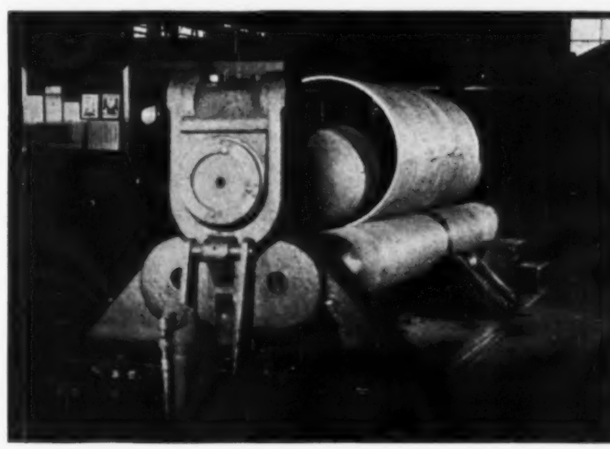


Fig. 12—Complete shells or sections of shells are rolled back and forth until they are cylindrical

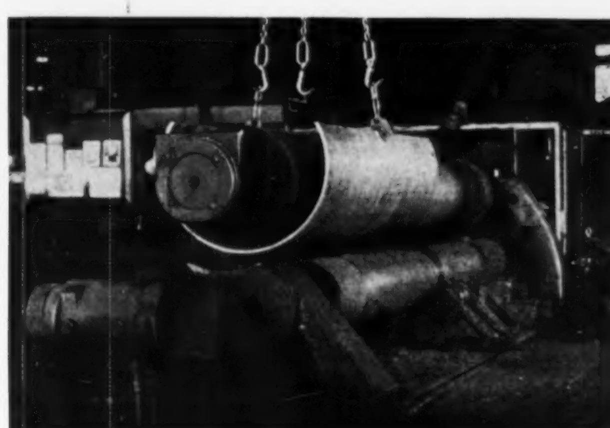


Fig. 13—Shell section being removed by a crane

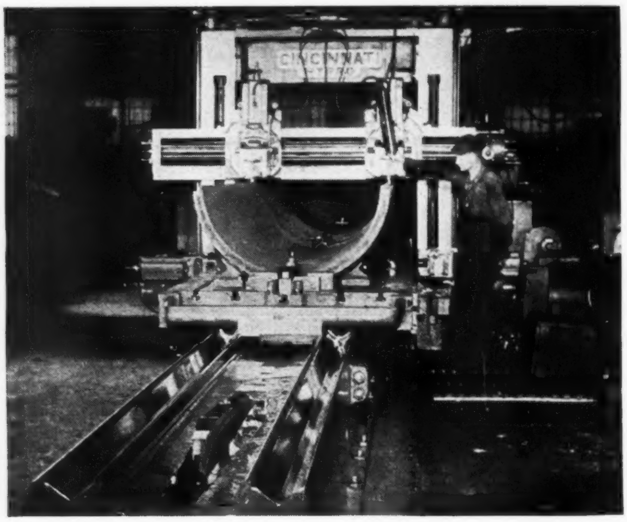


Fig. 14—Longitudinal edges are trimmed and machined in a planer for welding. Both edges are machined at the same time. Forming is so accurate that two or three shell sections may be set up in tandem and machined

Fig. 15—Vertical boring mill machining manhole flange of drum head

Fig. 16—Drum heads with flanged-in manholes being gaged after machining for welding

ner as the shell plates. When they are ready, they are removed, one at a time, by a group of men who guide a counterbalanced fork, on a crane hook, under a plate and take it to the head press where it is centered on a die and forced upward through a ring die to form the head to a true semi-elliptical shape. After cooling to room temperature, the manhole is flame-cut and prepared for welding the reinforcing plate in place. These plates are flame-cut and hot-formed after which manholes are flame-cut. After welding, the head is stress-relieved and is then ready for machining.

For heads with flanged-in manholes, the manhole opening is marked, flame-cut and ground and then the head and manhole are hot-formed. A die at the top of the press forms the elliptical manhole as the head is formed. After cooling, the manhole flange is trimmed with the flame cutter and if required, the manhole is cold-sized in a gooseneck type press. If there is insufficient surface for a gasket seat, a band is shrunk on the manhole flange and welded. From this point, the procedure on the two types of heads is the same. Manhole gasket seats and head flanges are machined in a vertical boring mill. Manhole openings of reinforced heads are machined in a specially designed eccentric mill. After completion of the machining operations on the head, nozzle openings are marked, drilled or flame-cut and nozzles are fitted, using a face plate, and welded before the head is welded to the shell.

Preparation for Welding

Upon the completion of the cold-forming operation on the shell, it is clamped on a large planer where the longitudinal edges are squared and machined for welding. The forming operation is so accurate that two or three sections of the same curvature and thickness can be set up in tandem and machined at the same time. When a shell has sections of unequal thickness, the outside and inside edges of the thicker section are tapered to meet the edges of the thinner section so that the neutral lines of the two sections coincide.

When the machining operations on the heads and shell sections have been completed, the various components are ready to be fusion-welded to form the drum.

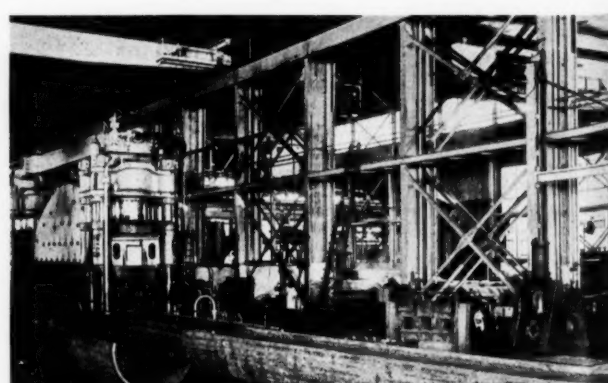


Fig. 17—View showing formed shell sections and 6000-ton press and crane in the background

Adaptability of Fuel Burning Equipment to Available Coals

A brief review of some of the conditions to be met in most efficiently burning presently available bituminous coals together with ranges in combustion rates for different types of fuel-burning equipment and their adaptability to various capacity units. The effects of certain coal characteristics are discussed.

INVESTIGATION of available fuels and their evaluation has long been recognized as prerequisite to the design of a steam plant and selection of its equipment, the latter also being influenced by capacity and character of load. Such a study goes beyond a comparison of fuel cost per million Btu and takes into account anticipated performance, initial investment, ash removal costs, maintenance and other operating costs, and flexibility.

While the war was in progress the diversion of premium bituminous coals to metallurgical and certain wartime uses, together with the large power demands, made it necessary for many consumers to burn coals having characteristics quite different, and often inferior to those for which their plants had been designed. This often led to operating difficulties and stressed the desirability of designing for burning effectively coals of a wide range in characteristics. Moreover, it would be futile to expect that the post-war fuel situation will revert to the pre-war status.

Premium coals are becoming scarcer and are no longer assured to many former purchasers; both labor and coal prices have advanced and are likely to rise higher; and changing conditions always introduce uncertainty as to the continuous availability of particular coals that may be desired. This situation has further crystallized the trend toward designing for the effective burning of coals of a wide range in characteristics in order that outage and maintenance may be minimized, together with assurance of maximum output and flexibility in handling fluctuating loads. The factors of chief concern are the volatile, ash content, burning characteristics and ash-fusion temperature. They have led to more liberal furnace volumes with accompanying lower heat release rates and, with certain capacity ranges, to the marked increase in spreader-stoker firing. Moreover, advancing fuel and labor costs have emphasized the importance of high efficiency with justified increase in investment costs, particularly for high load factor service.

Reports from abroad indicate that a somewhat similar situation prevails in England.

Following are some of the considerations to be kept in mind as having bearing on meeting present conditions when selecting fuel-burning equipment.

Combustion Rates and Capacity Ranges

A furnace designed to burn coals of low ash-fusion temperature must have greater heat-absorbing capacity and employ a lower heat release per cubic foot than one intended to burn only high ash-fusion temperature coal. Such heat release rates vary widely, dependent upon the type of firing employed. With pulverized coal the generally accepted range is 15,000 to 25,000 Btu per cu ft of furnace volume per hour; with single-retort underfeed stokers 30,000 to 40,000 Btu per sq ft of grate surface per hour; with multiple-retort stokers 30,000 to 40,000 Btu per sq ft; with chain- or traveling-grate stokers 25,000 to 35,000 Btu per sq ft. It will be noted that the rates for spreader stokers, which burn part of the coal in suspension, lie between those for pulverized coal and the traveling grate.

In individual cases the foregoing figures have been exceeded with high-grade coals but with poorer coals the emphasis is toward the lower part of these ranges.

With reference to capacity and type of firing, it may be pointed out that for outputs up to about 35,000 lb of steam per hour free-burning or caking coals can be burned with either single-retort underfeed or spreader stokers. However, where the coal is high in ash and has low ash-fusion temperature, reduced combustion rates are necessary with the underfeed stoker; hence in such cases the spreader type is usually preferable.

Chain- and traveling-grate stokers, when burning bituminous coals, are limited to the free-burning variety with sufficient ash content to protect the grate. They have been employed for various steam outputs up to 275,000 lb per hr, and in sizes from 50 to 670 sq ft of grate surface.

Spreader stokers, which are capable of burning either free-burning or caking coals, have a wide range in capacity application and, in the dumping-grate type, have been employed for outputs up to 125,000 lb of steam per hour. The continuous-discharge type, which combines characteristics and features of the spreader and the traveling grate, is applicable to capacities of around 200,000 lb per hr. Spreaders are low in first cost and maintenance and very flexible in meeting load swings, but require closer regulation of air and fuel feed than other types; for which reason a simple combustion control is advisable. At the higher combustion rates the carryover is greater than with other stokers; hence, it is often desirable to make provision for collecting the fly ash and returning it to the furnace for reburning.

Multiple-retort stokers, while ordinarily employed in capacity ranges from 35,000 to 300,000 lb of steam per

(Continued on page 45)

(Continued from page 43)

hour, have occasionally been installed for much larger outputs. They are adapted to burning caking coals.

Pulverized-coal firing, has the widest range of application and is employed for steam outputs from 15,000 lb per hr up to 1,000,000 lb per hr. While competitive with stokers, oil and gas firing in the smaller and medium capacity ranges, pulverized coal has the field to itself for large high-capacity units.

Important Factors

The aim in designing a steam-generating unit is to provide sufficent furnace volume so that the heat absorption by the water walls will keep the gas temperature entering the first pass of the boiler below the ash-fusion temperature. In the case of large pulverized-coal-fired units, vertically adjustable burners assist greatly in controlling the furnace exit-gas temperature over variations in load thus both minimizing slagging in this region and supplementing superheat control. Furthermore, where high-ash coals are to be burned, wider spacing of the first tube bank and lowered gas velocities through it and the primary superheater elements reduce the tendency to clog these passages, and also the cutting action of the ash on the metal.

Where a change is necessary from a high-volatile to a low-volatile coal, slower ignition will result and this may limit the minimum load that can be carried on a pulverized-coal-fired unit.

Moisture content will affect mill capacity, for which reason it is customary to select the pulverizer size for the maximum moisture expected. Furthermore, where the coal is high in moisture larger air preheaters are usually required, as insufficient drying may cause ignition difficulties at low loads. Sometimes the desired drying temperature is attained by supplementing and mixing the air from the preheater with gas withdrawn from the furnace, at a point remote from the burners and the flame envelope. Where the unit is too small to justify installation of an air preheater, furnace gas tempered with air from the boiler room may be used for mill drying.

Preheat temperatures with pulverized coal may be around 600 F, sometimes higher, but with stokers of all types it is seldom wise to exceed 300 F if excessive maintenance is to be avoided. Even this temperature may be too high with a rapidly changing load. For this reason the use of air preheaters with stoker firing will not result in as high overall unit efficiency as with pulverized coal. In such cases economizer surface often provides a more efficient means of heat recovery. Of course, most large pulverized-coal-fired units employ both economizers and air preheaters as maximum efficiency usually justifies the cost.

Where high-sulphur coals must be burned, the amount of heat-recovery surface may be limited, inasmuch as the leaving gases cannot be cooled below the point where corrosion would result.

The foregoing notes have been confined to the burning of bituminous coal which constitutes the basic fuel for power generation in this country. Much could also be written on the burning of oil, gas and waste fuels, but the supply of these is more or less regional or local and their comparison with coal usually involves specific economic studies.

EQUIPMENT SALES

as reported by equipment manufacturers to the Department of Commerce, Bureau of the Census

Boiler Sales

Stationary Power Boilers

	1945 Water Tube		1944 Water Tube		1945 Fire Tube		1944 Fire Tube	
	No.	Sq Ft*	No.	Sq Ft*	No.	Sq Ft	No.	Sq Ft
Jan.	‡96	‡534,669	36	226,537	50	60,710	24	37,701
Feb.	‡101	‡481,726	39	256,942	75	99,815	28	43,341
Mar.	‡134	‡759,214	47	229,121	77	87,266	44	53,893
Apr.	85	422,213	80	454,175	78	99,154	50	68,430
May	125	812,989	74	392,346	81	83,285	49	66,722
June	‡187	‡1,276,996	63	275,450	90	106,085	70	92,621
July	201	1,021,897	78	457,442	88	134,714	56	67,126
Aug.	‡152	‡853,258	112	442,766	‡105	‡139,936	52	69,832
Sept.	150	1,000,878	123	532,895	99	128,948	52	68,783
Oct.	147	823,329	119	603,687	120	148,768	65	79,289
Nov.	157	804,089	135	489,772	98	126,425	68	82,182
Dec.	160	1,051,240	56	367,755	117	147,974	55	78,829
Jan.–Dec., incl.	1,695	9,842,998	962	4,728,889	1,078	1,363,080	613	802,740

* Includes water wall heating surface. ‡ Revised.

Total steam generating capacity of water tube boilers during the period Jan. to Dec. (incl.) 1945. 89,466,000 lb per hr; in 1944, 36,566,000 lb per hr.

Marine Boiler Sales

	1945 Water Tube		1944 Water Tube		1945 Scotch		1944 Scotch	
	No.	Sq Ft*	No.	Sq Ft*	No.	Sq Ft	No.	Sq Ft
Jan.	‡335	‡1,400,090	49	273,879	6	1,073	—	—
Feb.	34	178,726	96	507,658	5	1,186	30	9,000
Mar.	‡49	‡193,124	70	226,166	10	7,685	38	9,700
Apr.	16	65,252	44	209,906	4	2,126	48	14,405
May	‡22	‡100,362	94	443,130	2	526	37	11,100
June	21	114,537	193	1,003,435	22	7,605	32	13,100
July	47	248,664	113	392,704	12	3,352	22	8,120
Aug.	39	133,420	182	811,978	5	1,221	26	11,983
Sept.	34	105,803	14	23,768	1	427	22	9,781
Oct.	2	22,720	52	67,560	4	2,809	36	16,085
Nov.	6	23,975	19	164,458	1	520	23	11,262
Dec.	8	37,600	60	283,878	3	997	12	7,540
Jan.–Dec., incl.	613	2,624,273	986	4,413,738	75	29,527	326	122,076

* Includes water wall heating surface. ‡ Revised.

Total steam generating capacity of water tube boilers sold in the period Jan. to Dec. (incl.), 1945, 29,503,000 lb per hr; in 1944, 55,032,000 lb per hr.

†Mechanical Stoker Sales

	1945 Water Tube		1944 Water Tube		1945 Fire Tube		1944 Fire Tube	
	No.	Hp	No.	Hp	No.	Hp	No.	Hp
Jan.	‡42	‡18,990	35	13,982	‡187	24,899	149	20,961
Feb.	‡57	‡22,510	34	18,437	162	20,565	158	22,655
Mar.	‡87	‡32,451	‡56	‡20,128	‡233	32,447	150	22,884
Apr.	‡57	‡21,004	‡69	‡26,461	‡197	‡27,358	183	25,838
May	‡101	‡40,470	‡54	‡20,920	‡240	‡32,456	225	30,817
June	78	33,644	57	21,055	‡249	‡34,183	295	35,952
July	160	71,025	80	28,543	‡265	‡34,286	290	41,910
Aug.	‡98	‡40,309	115	35,077	‡348	‡43,182	359	48,612
Sept.	95	45,147	110	34,586	333	44,941	296	36,268
Oct.	98	43,284	90	29,936	367	51,493	328	44,262
Nov.	70	31,295	120	33,489	330	45,225	242	29,799
Dec.	67	31,448	103	34,626	264	31,932	277	35,764
Jan.–Dec., incl.	1,010	431,577	923	317,230	3,178	423,367	2,952	395,722

† Capacity over 300 lb. of coal per hour. ‡ Revised.

A perusal of the foregoing figures reveals an increase of approximately 75 per cent in the number of both water-tube and fire-tube boilers sold in 1945 over 1944, whereas the square feet of heating surface involved is more than double in the case of water-tube boilers. This reflects the activity in this field after the Government had revoked the restrictions on the sale of new boilers with the termination of hostilities. The large number of fire-tube boilers sold indicates that this type of unit is still in large demand for small units for certain types of service.

The decrease in marine boilers follows the curtailment in the Maritime Commission program.

The increase in stoker sales is not as marked as in the case of boilers. This is as would be expected, inasmuch as most of the larger steam-generating units are fired by pulverized coal.

Chemical Cleaning of Boilers and Heat Exchangers

EXPERIENCE with acid cleaning of boilers and heat-exchange equipment was reviewed at a panel discussion of the New Jersey Division, Metropolitan Section of the A.S.M.E. held at the Essex House, Newark, N. J., on March 6. Those participating in the panel represented both industrial and utility companies. They were: D. C. Carmichael of E. I. du Pont de Nemours & Company; Fred Eberle of the Standard Oil Development Company; J. C. Mack of Tidewater Associated Oil Company; W. L. Mann, Power Engineer of National Lead Company; S. W. Shepard of Calco Chemical Company; and L. A. Winkelman of the Public Service Electric & Gas Company. Many others participated in the discussion. The wide interest in this subject was attested by an attendance of about three hundred.

At a dinner preceding the panel discussion, L. E. West of Dowell, Inc., gave a talk with slides illustrating the equipment and procedure employed by his company in acid washing.

Mr. Shepard told of his company's experience in cleaning the water side of condensers, heaters and heat-exchangers where scaling had limited the ability to carry load and periodic acid washing had become a necessity. Inhibited muriatic acid is employed generally, although sulphuric acid, or a mixture of muriatic and sulphuric acids have also proved effective. Considerable experimentation has been made with different inhibitors, both commercial and company produced, and excellent results were obtained when employing benzothiazole for this purpose; in fact, it has proved more stable than the propriety compounds tried. It was found that inasmuch as the composition of the metal has much to do with the corrosion rate, this influences the effectiveness of the corrosion inhibitor.

Mr. Eberle related that his company's first experience with acid washing concerned the economizer section of a 650-psi boiler. Different sections were blocked off and the cleaning solution of 3 per cent inhibited muriatic acid was maintained at 140 F for 5 hours, the end-point being determined when the acid strength had dropped to 75 per cent. This was followed by a caustic wash and flushing with clean water.

At one of the company's southern refineries a 600-psi, 200,000-lb per hr boiler had been cleaned with an 8-per cent acid solution and showed excellent results at a saving of $300 over mechanical cleaning. The method has also been employed in cleaning boilers at eastern and western refineries with various savings in expense and in all cases large reductions in the time necessary for the boilers to be off the line. The method is now also employed for cleaning various refinery heat-exchanger equipment, with substantial savings in both outage time and labor.

This panel discussion revealed the extensive use of acid cleaning for scale removal from boilers, condensers, heaters and process equipment by a large number of utilities and industrial plants. Large savings in time, labor and outage were reported. Experience has shown temperature of the solution to be a most important factor in avoiding breakdown of the inhibitor; the lower the percentage of acid employed the higher the permissible temperature. Results with various inhibitors were noted and the conclusion reached that there is no perfect inhibitor. Precautions against hydrogen explosion and proper preparation of the unit for cleaning were stressed.

In general, best results for boiler cleaning had been obtained with a 2 to 3 per cent inhibited acid solution at 140 to 150 F for a period of 6 to 8 hours. Experience with surface condenser cleaning had dictated the use of a 7 per cent acid solution for 15 to 30 minutes.

Mr. Mann told of his experience with the two large boilers at the company's South Amboy plant. These had been in service about ten years when during the peak of war production, some two years ago, a tube had failed by overheating and damaged adjacent tubes to the extent that the unit had to be taken out of service. Inspection revealed serious plugging of many tubes. It was a coincidence that this happened the day after he had been approached by the representative of a company specializing in acid washing. Before anything could be done about this unit, the second boiler failed from the same cause and the plant was shut down, even to the extent that there was no hot water available for washing the second boiler. This unit which had not been severely damaged was immediately acid washed, the hot water being provided by filling, adding acid at the top and lighting a small fire in the furnace. The other boiler was later repaired and washed by supplying the inhibited acid solution through the bottom blowoff. It has now been back in service for more than 14 months.

At this plant acid washing has since been employed to clean plugged heaters, surface condensers and 1000-ft of 6-in. water-main. Where a heater tube is found to be completely plugged it is is necessary first to bore a hole for the passage of the cleaning solution. In instances where high silica scales were encountered, fluoride was employed to supplement the muriatic acid. The speaker also mentioned the necessity of being sure of the liquid capacity of a unit before undertaking acid washing.

Mr. Mack's remarks were confined to experience in cleaning heat-exchange equipment at his company's Bayonne Refinery during the past two years. Unlike the chemical companies, no waste products were available for experimentation as inhibitors; hence, the regular Dowell service is employed. He cautioned that when cleaning, old piping pits may become exposed by the removal of scale, and leaks may result; therefore, inspection or testing is desirable. Some deposits had been encountered containing up to 85 per cent carbon air; but inasmuch as no solvent will remove such a deposit, sand-blasting became necessary.

Mr. Carmichael stated that his company's experience with acid cleaning had dated back to 1927 on condensers, cooling jackets and heat-transfer equipment and has since been generally employed for washing boilers. A 10-per cent inhibited muriatic acid solution at 160 F for about 10 hr followed by soda washing and water flushing was recommended. No failures have resulted, although some corrosion has been noted in a few cases. Tri-sodium phosphate has been found effective in building up a protective film.

The first time acid washing is employed the cost may exceed that of mechanical cleaning, because it is usually desired to open up the equipment for inspection, before and after; but when such cleaning becomes a scheduled procedure savings are effected. In one plant, cited by the speaker, annual savings from reduced outage and less labor had amounted to about $25,000. He cautioned that experienced personnel is necessary in carrying out the washing operations and that it is always preferable to employ new acid than attempt to build up the strength of old solutions. Employment of air to agitate and carry off the sludge was recommended.

Mr. Winkelman stated that his company employs acid cleaning for boilers, feedwater heaters and condensers. He described in detail the procedure employed for washing the high-pressure boilers and cautioned against too frequent cleaning of condensers having cast-iron water boxes, inasmuch as inhibited acid attacks cast iron. In all cases no higher temperature should be employed than necessary to remove the scale, which is usually about 140 F; and precautions should be taken against hydrogen explosion by adequately ventilating the drum or other equipment being washed. The practice at Kearny Station calls for acid washing the boilers at one-year intervals, with feeding through the safety valves. There had been some

tube failures from pitting in the high-pressure boilers after two years of service.

Discussion

W. S. Patterson, of Combustion Engineering Company, confined his remarks to experience in acid washing large high-pressure forced-circulation boilers, such units being especially adapted to this method of cleaning. Their relatively small water content makes for shorter time in filling and draining, and involves the use of very much less acid solution than a natural-circulation boiler of like capacity; also the employment of all-welded construction eliminates gaskets that may be attacked by the acid. In fact, the small tubes and tube arrangement would render mechanical cleaning difficult and, in some cases, impossible.

The 650,000-lb per hr Montaup boiler, which was designed especially for acid cleaning, requires only about an hour to drain completely. Unless a uniform temperature is maintained throughout a unit the acid solvent will be less effective where lower temperatures prevail. And since it is difficult to maintain a uniform temperature when a large unit is down, especially if men are working on certain parts, circulation is important. In the case of the Montaup boiler, one of the circulating pumps was employed intermittently to circulate the acid solution and thus provide both uniform temperature and uniform concentration throughout the tubes, the former being checked by thermocouples. Inasmuch as it requires less than a minute to completely circulate this unit, this brief time produced no adverse effects on the impeller blades.

The speaker urged the desirability of providing all new boilers, regardless of type, with adequate filler and drain connections to save time in these operations.

L. H. Coykendall, of Babcock & Wilcox Company, reported on a survey of eighteen central stations employing acid cleaning. This, in some instances, showed some loss of metal each time a boiler was cleaned, which suggested the desirability of doubling the amount of inhibitor and making sure it is adequately mixed. Most inhibitors tend to break down at around 160 F; intensifiers should not be used; and wetting agents are likely to cause localized attack on the metal. The attack on metal usually results from too high temperature in an effort to shorten the time. The speaker urged the desirability of filling the boiler from the lowermost point, as filling from the top is likely to result in cascading and does not assure the solution reaching all parts. He observed further that chemical cleaning, despite its advantages, should not be regarded as a substitute for proper feedwater treatment.

H. E. Einert of Cyrus W. Rice & Co. pointed out that proper temperature of the solution is the most important factor. It has never been possible to completely inhibit cast iron, but if the temperature is kept to 100 F or lower, this will help. The most difficult deposit to remove, he said, is iron oxide in the ferric state.

John Nichols, of Hagan Corporation, also cautioned against temperature being allowed to go too high and advised heating the solution of water and acid before being

introduced into the boiler, rather than raising its temperature within the unit.

Mr. **Pratt,** of Worthington Pump & Machinery Corporation, discussed pumps for acid washing and advocated pumps of high silicon iron for such service. He pointed out that whereas solutions of low acid content can be used at higher temperatures, those that contain 12 to 15 per cent acid should be limited to 100 F. If tubes are plugged with scale, the pump will churn, the liquid will boil and the pump will be damaged, unless it is provided with a bypass.

I. B. Dick, of Consolidated Edison Company, New York, told of the practice of his company in acid cleaning boilers once a year on regular schedule. Cleaning is accomplished in less than 24 hr and the principal scale removed is magnetic oxide of iron. Condensers and feedwater heaters are also cleaned by this method, necessity for the former being indicated when the vacuum decreases 0.1 inch. Slight corrosion has been noted, at stress locations such as tube holes, but this has not been serious. He was of the opinion that no perfect inhibitor has yet been developed.

Further discussion suggested a mixture of muriatic acid, lactic acid and oxalic acid as effective for cast iron; that removal of sulphate scale requires two-stage treatment; that it is possible to remove mill scale by acid washing; and that the preliminary preparation of getting equipment ready for acid washing is a most important factor in reducing cost and in effective cleaning.

Battersea Station

One of the best known power stations in England is the Battersea Station of the London Power Company, the original section of which was completed in 1933. At the time it attracted wide attention and was publicized in this country because of its elaborate flue-gas washing system and later because of its performance in attaining the distinction of becoming Britain's most efficient electric generating station. The plant was extended in 1938 by an addition designated as Station "B," the capacity of which is now being further increased.

Successive steps in the building of this station are reviewed in a report by the London Power Company, published in *The Engineer* (London) of December 21, and comprise the following:

The original Station "A" contains two 60,000-kw and one 105,000-kw turbine-generators supplied with steam at 600 psi, 850–875 F by six 250,000-lb per hr and three 300,000-lb per hr stoker-fired boilers. The station efficiency attained in 1938 was 28.98 per cent, gross, or 27.63 based on station output.

The initial installation in Station "B," made in 1938, comprised one 100,000-kw turbine-generator served with 1350-psi, 950-F steam by 550,000-lb per hr stoker-fired boilers, supplied with 400–420 F feedwater. The turbine-generator is a cross-compound machine, the high-pressure unit being rated at 16,000 kw and the low-pressure unit at 78,000 kw; the latter normally receives exhaust from the high-pressure unit at 600 psi, but is arranged so that it may operate with 600-psi steam from Station "A." A 6000-kw house turbine is driven from the same shaft.

Extension to Station "B"

The first extension to Station "B" is now going in and comprises a 60,000-kw, 3000-rpm hydrogen-cooled turbine-generator of the three-cylinder type on a single shaft with a double-flow low-pressure element exhausting to twin condensers. It will be supplied with steam at the existing station pressure and temperature by three 320,000–400,000 stoker-fired boilers, one of which is being arranged to burn up to 20 per cent of its fuel in pulverized form. This is in the nature of an experiment in view of the poor quality of coal now being supplied. In this case there will be no connection with the 600-psi mains in Station "A." In place of the main shaft-driven house turbine, as employed in the previous installation, there will be a separate 6000-kw house service unit, operating at 600 psi.

In view of the increased consumption of steam for soot blowing, due to probable fouling of heating surfaces when burning inferior coals, the makeup from a single-effect evaporator was deemed insufficient and a triple-effect thermo-compressor type of evaporating plant of 45,000 lb per hr capacity is therefore being installed.

When this extension has been completed there will still be space available for equipment to constitute the remaining third of the ultimate plant capacity. Although final plans are not yet ready, it is anticipated that they will include a 100,000-kw turbine-generator and three 320,000–400,000-lb per hr boilers (Nos. 15, 16 and 17). This would bring the total capacity of the station up to 509,000 kw of which 33,000 would be house service.

Operating Performance

During a recent week's run the high-pressure plant showed a gross thermal efficiency of 31.5 per cent based on the electric energy generated, whereas the figure for the whole station, comprising the 600-psi and the 1350-psi sections, was 29.9 per cent gross.

Revision of Pulverized Fuel Standards

After a lapse of ten years since the last revision, a new edition of standards for the installation of pulverized-fuel systems was approved November 30 and has now been printed for distribution by the National Board of Fire Underwriters.

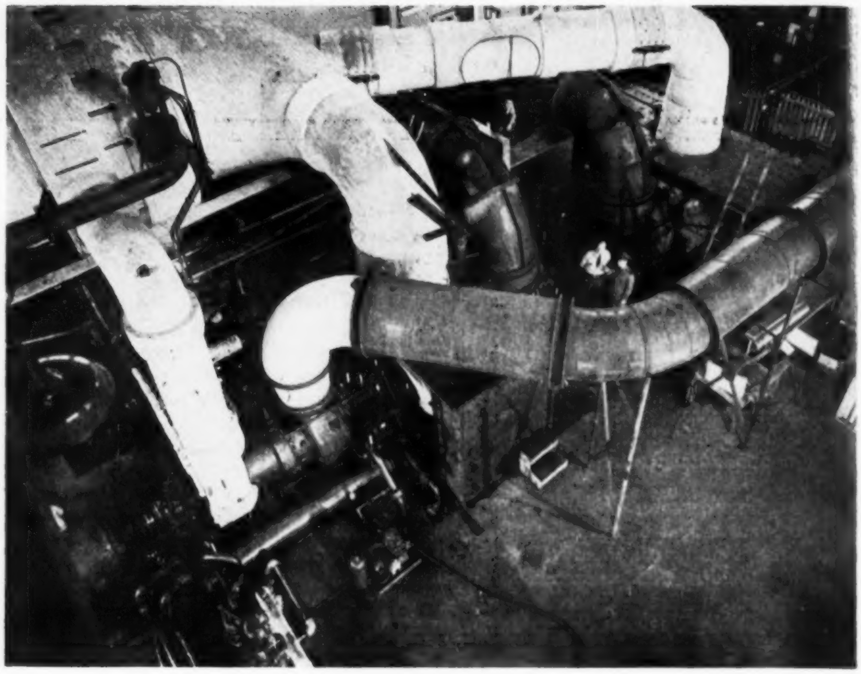
During the elapsed time there has been considerable evolution in the design and application of pulverized-coal systems, based on ever-widening experience, and cognizance of this is taken by the revised code. For instance, experience has demonstrated that dependence cannot be placed upon relief doors to protect against the effect of an explosion and this is now recognized by the code, although regulations of some states still prescribe them.

While mills, exhausters, feeders and piping are still required to be designed to withstand an internal pressure of 50 psi, it is significant that the safety factor of 4 no longer applies to all parts of the system. Except where cast iron or other nonductile material is involved, a factor of 2 is now permissible for flat areas and sections subject to bending.

The previous standards sanctioned taking flue gas from the breeching for mill drying, but it is now permissible, under the standards, to take hot gas for this purpose from the furnace at a point remote from the burners or flame, provided it is tempered with cold air, preferably near the outlet from the furnace; and provided further, that if two or more mills are connected to the same source of hot air, valves be placed to prevent the flow of hot air to a mill not in operation. This means of mill drying is sometimes employed when air preheaters are not installed, or where they are employed and the air temperature is not sufficient to dry very wet coal.

The considerable amount of space in the 1935 edition that was devoted to storage systems, particularly the construction of the preparation building, has been greatly condensed, undoubtedly in view of the fact that there have been practically no *new* storage systems installed within recent years.

The text dealing with interlocks and ignition torches has been greatly amplified, and numerous sketches of system arrangements have been included.



Turbine on test floor

Gas Turbine of 3500 Hp Operates at 1350 F

Successful operation at a gas temperature of 1350 F has been accomplished in a series of increasing temperature tests on an Allis-Chalmers experimental gas turbine plant installed in the U. S. Naval Engineering Experiment Station at Annapolis. Designed for eventual operation with hot gas at 1500 F, this 3500-hp unit is claimed to be the first large multi-stage gas turbine for continuous power generation at high efficiency to be operated successfully at such high temperature.

The plant is arranged with two turbines operating in parallel, one supplying power required to drive the compressor, the other furnishing the external shaft power. Fresh air enters the compressor at 40,000 cfm and is discharged at 45 psi to the heat exchanger where it picks up heat from the turbine exhaust. The heated air then passes through two separately oil-fired combustion chambers where it is further heated to the desired turbine inlet temperatures. The gases then expand in the two multi-stage turbines.

The Floating Power Plants

It will be recalled that the Government in 1942, sensing the possibility of a power shortage or a need for emergency service in some localities, laid down four 30,000-kw floating power plants. Each, consisting of two boilers supplying steam at 835 psi, 910 F to a 30,000-kw condensing turbine-generator, was installed on a relatively shallow-draft barge which could navigate many of the inland waterways. However, few emergencies arose to require their use during the war, although one of the units has for some months been supplementing the power supply to Jacksonville, Florida. Another was subsequently taken abroad where it served to supply emergency power in Belgium, and will shortly be returned to the United States for want of a purchaser abroad. A third unit, the "Seapower" is now at the Philadelphia

Navy Yard where it is being offered for sale by the Reconstruction Finance Corporation. The fourth was last reported to be at Manila.

The steam conditions are in line with central station practice for a plant of this capacity and on test these plants are reported to have shown excellent performance and low station heat rate.

Slight Drop in Energy Demand

Electric energy produced for public use in January 1946 totaled 18,392,948 kwhr, according to a report issued March 5 by the Federal Power Commission. This represented a decrease of 9.3 per cent from that of January 1945. The average daily output was slightly below that of December.

Coal used by utility power plants during January 1946 amounted to 5,962,922 tons of which 5,701,978 tons were bituminous. Approximately 38.7 per cent of the kilowatt-hours generated represented hydroelectric power.

As of January 31, 1946, the total installed capacity was 50,184,165 kw.

La Mont Boilers on German Cruiser

The German heavy cruiser Prinz Eugen which has been in this country for some weeks past and which will be one of the vessels to undergo atomic bomb tests at Bikini Atoll the middle of May, is of special interest to power engineers because of the propelling machinery. Said to be capable of 33 knots at 135,000 shaft horsepower, her three sets of geared turbines driving triple shafts are supplied with steam at 880 psi, 930 F (maximum) by twelve La Mont forced-circulation boilers located in three boiler rooms. These boilers are said to have been designed for much higher pressure but the operating pressure was governed by turbine availability as dictated by destroyer installations then under construction.

A closed stokehold system is employed under about 14 in. wg and each furnace is fired by two rotary air-turbine-driven burners. Economizers and tubular air heaters are provided. Flanged fittings, rather than welding, are employed for the piping and expansion is taken care of by corrugated sections. The layout is such that all three turbines normally take steam from each boiler room, the number of boilers in service depending upon the power output required; that is, upon the speed. However, cross-connections are such as to permit several combinations should one or more boilers be out of commission. Automatic combustion control is employed.

Joseph B. Crane

Joseph B. Crane, Export Manager of Combustion Engineering Company, died suddenly of a heart attack at his home in Bridgewater, Conn., on March 9 at the age of 66.

Born in Waterbury, Conn., and graduated from Trinity College in 1902, Mr. Crane joined the test department of General Electric Company, later becoming assistant superintendent of that department. From 1907 to 1915 he was commercial manager of the Great Northern Power Company at Duluth. For the next three years he was with the American & Foreign Power Company engaged in investigations and reports on South American properties. He then became vice-president of the Lehigh Power Company and early in 1921 joined the Ladd Boiler Company. When the latter company was acquired by Combustion Engineering Company in 1925, he became Pittsburgh District Manager which position he held until 1937 when he was made manager of the Export Department. He had made numerous trips to South America and was

well known in those countries, as well as having many friends in the utility and industrial power fields in this country.

Mr. Crane was a member of the American Society of Mechanical Engineers, the Brazil-American Association, the Peruvian-American Association and had been active in the Foreign Trade Council. He was the author of numerous engineering society papers and a contributor to the technical press.

Surviving are his wife, Isabelle F. Crane, two sons and two sisters.

Funeral services were held in St. Marks Protestant Episcopal Church, Bridgewater, Conn., on March 11.

A.S.M.E. Spring Meeting to Consider Power Problems

The program announced for the A.S.M.E. Spring Meeting to be held in Chattanooga, Tenn., April 1 to 3, inclusive, contains sessions on steam power, hydroelectric power and diesel power.

Registration will be on Monday morning and at the Monday afternoon session on hydraulics the three papers scheduled are: "The Design of Mechanical Auxiliaries for the T.V.A. Hydroelectric Plants," by H. J. Peterson, mechanical engineer for the T.V.A.; "A Better Method of Representing and Studying Water Turbine Performance," by R. A. Sutherland, hydraulic engineer of Ebasco Services, Inc.; and "The Nantahala Turbine," by J. B. Growdon and H. H. Gnuse, Jr., of the Aluminum Company of America, and R. V. Terry of the Newport News Shipbuilding and Dry Dock Co.

A simultaneous session on Diesel Prime Movers will include two papers, the first on "Maintenance of Diesel Locomotives Under War-Time Conditions in Europe," by Isham Mann of the Byers Pipe Company; and the second "Electro-Hydraulic Regulators for Diesel-Electric Drives," by M. A. Edwards and C. B. Lewis, both of the General Electric Company.

On Monday evening the Power Session will have a paper on "Power at Oak Ridge," by L. Skog and H. C. Schroeder of Sargent & Lundy, Chicago. This will be followed by a symposium on "Corrosion in Power Plant Operation." Participating in this will be W. C. Carmichael of E. I. du Pont de Nemours Co.; Dr. M. G. Fontana, Professor of Metallurgy, Ohio State University; W. L. Webb of the American Gas & Electric Service Corp.; J. A. Reich of the Virginia Electric Power Co.; John Van Brunt, Vice President of Combustion Engineering Co.; and Ray Benjamin of the Georgia Power Co.

A session on Power and Fuels is scheduled for Tuesday afternoon and will offer the following three papers: "Smokeless Furnaces and Stoves," by Prof. J. R. Fellows of the University of Illinois; "Testing and Rating of Space Heaters," by W. H. Baskerville, of the University of Tennessee Experiment Station; and "Modern Steam Generators," by C. L. Huey of Babcock & Wilcox Co.

Other sessions will deal with the process industries, metals, welding of locomotive boilers, aviation, education and training, and management.

Several luncheons are scheduled. That on Monday will be held jointly with the Chattanooga Engineers' Club and will include a talk on "Air Transportation and World Understanding," by J. P. Van Zandt of Brookings Institution, Washington, D. C. That on Tuesday will include a talk on "Sidelights on Penicillin and Related Substances," by Dr. J. W. Grote of Chattanooga. A third luncheon, on Wednesday, will consider "Industrial Development of the Southeast," with J. P. Ferris, Director of the Commerce Dept., T.V.A. as the speaker.

The banquet will be held on Tuesday evening with E. E. Williams, General Superintendent of Steam Plants of Duke Power Co., as Toastmaster. L. G. Haller, of the Tennessee Eastman Corp., will welcome the guests and an address will be given by D. Robert Yarnall, President of the A.S.M.E.

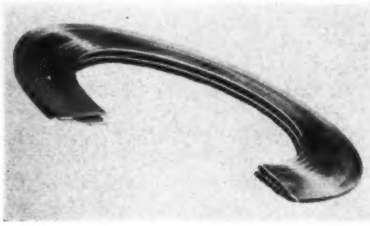
Inspection trips include one to the Chickamauga Dam and Power Plant of the T.V.A. on Monday morning; a visit to the Hedges-Walsh-Weidner Division of Combustion Engineering Co. on Tuesday morning, and visits to the Ross Melham Foundries and the Chattanooga Glass Works on Wednesday afternoon.

Headquarters will be at the Read House.

NEW EQUIPMENT

New Gasket

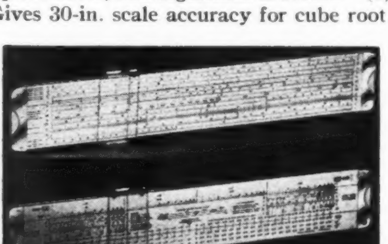
Goetze Gasket and Packing Company has announced a new and unique gasket design which uses the pressure to be sealed to exert a corresponding sealing pressure on the flange faces.



This serrated-type gasket, known as Bellowseal, consists of two disks of metal (Armco iron, low-carbon steel, Monel or stainless steel) machined on their external faces with standard serrations and welded together around their outer periphery. It combines the pressure and corrosion-resistant qualities of all metal gaskets with the light bolting requirements of a softer sealing medium. Line pressure entering the interior of the gasket exerts expansion pressure in excess of the required sealing force.

New Deci. Point Slide Rule

Pickett & Eckel announces that its new Deci.Point Slide Rule is the first to place the decimal point at the end of long and intricate computations. It also features a simplified arrangement of scales to facilitate and point off problems containing cube root, square root, logarithmic and trigonometric factors. In these and in all other slide rule operations it is claimed that the Deci.Point user enjoys the following additional advantages: (1) Places the decimal point mechanically up to 19 digits or zeros. (2) Same setting of hairline for result also gives readings for cube and square roots, and logarithm of result. (3) Gives 30-in. scale accuracy for cube root.

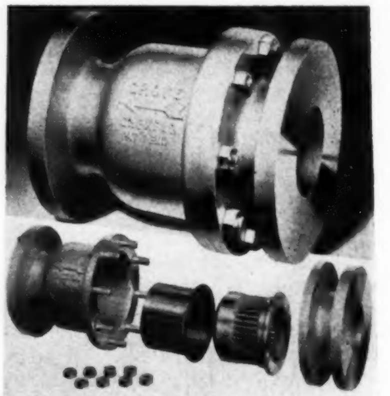


(4) Gives 20-in. scale accuracy for square root. (5) Simplifies slide rule calculations so that relatively complicated expressions can be evaluated and pointed off by users with a limited mathematical background.

The core of the Deci.Point Slide Rule is of light-weight Dowmetal and is surfaced with a flat white plastic that is impervious to water or chemicals and virtually immune to abrasion. With each Rule a Manual is provided which covers all phases of slide rule operation as well as Decimal Point Location.

New Check Valve

The Grove Regulator Company claims that, from the standpoint of design, construction and operation, the Grove Chexflo Valve represents the utmost in simplicity and safety. Operation is effected by a synthetic rubber tube, stretched over a slotted, cup-shaped metal core, which expands to open and contracts to close. Due to the fact that this expansible tube closes instantly on balanced flow, prior to the commencement or back flow, there is never any tendency to establish pressure impulses, shock or water hammer through the flow line. The flexive tube possesses a uniform and constant spring rate which avoids inertia being set up to cause operation beyond flow requirements. Because of its self-compensating and wear-resistant factors this unit is particularly suited for handling the most highly corrosive and erosive air, gases or liquids.



New Magnetic Adjustable-Speed Drive

Precise, wide-range, quick-response speed control for boiler draft fans, centrifugal pumps, blowers and compressors is claimed for the new E-M Magnetic Adjustable-Speed Drive, manufactured by Elec. Machinery Mfg. Company. Consisting of a rotating ring and a rotating magnet, the Magnetic Drive is a compact, self-contained, electro magnetic torque transmitter used in combination with a constant speed a-c motor and an electronic controller to provide split-revolution speed control.

Built in ratings approximately 25 hp and larger at 1800 to 600 rpm, the Magnetic Drive is available in several forms to meet the requirements of new or existing installations. It provides substantial power savings by operating boiler draft fans at reduced fan speed for partial fan output, eliminating the need for damper or inlet vane control.

The Magnetic Adjustable-Speed Drive can be used in combination with synchronous motors to provide power factor correction.

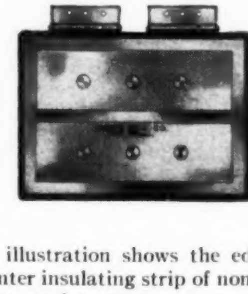
New Construction Principle in Flexible Tubing

Spiratube Division of The Warner Brothers Company announces a new type of flexible tubing which already has had two and one-half years of service in the U. S. Navy. It is non-collapsible under plus or minus pressures and retractable to about one-eighth of its extended length. It may be used for portable or semi-permanent ventilation or any handling of air, gases or light solids.

A feature of Spiratube construction is the method of spiral-stitching the spring steel helix core within the fabric. The inside surface is free of wire ridges and sharp bends can be made with only a slight reduction of air flow and without the use of elbows and special fittings. Standard Spiratube is made of long-fiber duck having a bursting strength of 170 psi; the fabric is processed fire-resistant and covered with tough, durable plastic. It is furnished in standard diameters from 3 in. to 16 in., and in lengths of 10, 15 and 25 ft. Built-in couplings permit quick joining or disconnecting.

Non-Electric Stainless Steel Magnet

The successful development of a powerful, compact, nonelectric magnetic separator with a working surface made entirely of stainless steel is announced by Eriez Manufacturing Company. It is claimed that Eriez magnets, properly installed ahead of stokers, will efficiently remove large and small pieces of tramp iron and steel before they enter the furnace and cause serious damage, and can be built to fit all types of machines or conveying equipment.



The illustration shows the edge strips and center insulating strip of nonmagnetic stainless steel to prevent strength of the unit from magnetizing the steel on which it is mounted. The two "pulling" areas on each side of the center insulating strip are made of magnetic stainless steel. These magnets need no wiring, power being furnished by the Alnico steel magnet castings. Under normal conditions their strength will last indefinitely, according to the Eriez Manufacturing Company, which backs up its product with a ten-year unconditional service guarantee.

NEW CATALOGS AND BULLETINS

Any of these publications will be sent on request

C-E Steam Generator

Combustion Engineering Company has published a new 28-page catalog (No. VU-4) featuring its well-known Type VU Steam Generator. This standardized unit, of which many hundred are in service, has been installed for design pressures up to 1000 psi, total steam temperatures to 910 F, and for capacities ranging from 15,000 to 300,000 lb of steam per hour. The VU unit may be fired with pulverized coal, oil or gas, or by any of the commonly used mechanical stokers, such as the spreader, underfeed, or traveling grate types.

The present catalog depicts design and construction features of this unit in considerable detail, including drum internals, tube assemblies and water-tube wall materials and construction. Numerous installation and construction views are shown as well as a variety of typical cross-sectional drawings illustrating the adaptability of the VU-type Steam Generator to any desired conditions or requirements.

Condensers and Coolers

The Griscom-Russell Company has prepared a new 8-page bulletin (1230) which describes and illustrates the Fin-Fan Exchanger, a "package-type" unit jointly developed by G-R and The Fluor Corporation, Ltd. Many advantages are claimed for this exchanger for condensing and cooling fluids without the use of water and typical applications are listed to show the wide adaptability of the unit. The final portion of the bulletin describes the Griscom-Russell K-Fin Air-Cooled Section in detail.

Indicating Flow Meters

The Hays Corporation announces the Hays Veriflow Meter for measuring, indicating and totalizing various liquids used in industry. The outstanding feature of the new meter is its ability to indicate the rate of flow at a point remote from where the meter is installed. This is in addition to the rate of flow indication and integrator which are integral with the meter itself. To secure the remote indication the generator is mounted on top of the flow meter, the same shaft operating both the generator and the totalizing register. No external source of electricity is required because the indicating meter measures the output of the generator and is calibrated to indicate the corresponding rate of liquid flow through the meter. The scale of the indicator can be calibrated to read in any values of flow desired such as gallons per minute.

H-P Condensate Return System

The Cochrane Corporation has issued a bulletin (No. 3250) which describes its new high-pressure condensate return system. Benefits claimed for the system will include the establishment of higher heat transfer rates of definite uniformity and more heat from the same pressure of steam complemented by lower fuel costs and increased boiler capacity.

Deaeration

A restatement of the science of deaeration and its effectiveness in controlling corrosion is the major part of a 20-page booklet issued by the Elliott Company. Fully illustrated with charts and photographs, the booklet describes corrosion in general and the part which deaeration plays in checking it. Included in the text is a table showing the derivation of the pH factor and a graph indicating the effect of pH on the rate of corrosion. Additional graphs cover the solubility of oxygen and carbon dioxide in water at various temperatures and the solubility of the oxygen component of air in distilled water at various temperatures and pressures.

Fan Standards, Definitions and Terms

The National Association of Fan Manufacturers has just issued a new bulletin (No. 105) entitled "Standards, Definitions, and Terms In Use By the Fan and Blower Industry". In this 12-page publication the attempt has been made to consolidate all of the standards generally recognized and accepted by the Industry. Fan classification, terms, definitions, and abbreviations are also included. The experience on the effect of abrasion and on field tests of fans is likewise covered for the benefit of the buying public.

Feed Water Control

Northern Equipment Company has published an attractive 24-page bulletin (No. 441) entitled "Copes Boiler Feed Water Control for High-Duty Boilers." The bulletin graphically illustrates the Flowmatic principle, its characteristics and features and shows performance charts of results obtained in five typical installations using Flowmatic systems. Full-page schematic diagrams in color illustrate the Copes Flowmatic control with thermostat direct-connected to a relay-operated valve, and also the control system for remote operation.

Feed Water Heaters

The Swartwout Company has issued an 8-page bulletin (5-18-E) which describes and illustrates its line of Deaerating and Standard Open Feed Water Heaters. Illustrations include unit and installation views, and a cutaway view showing the special features of this type of heater.

Flow Rate Measurement

Fischer & Porter Company has issued the third edition of its Catalog Section 10-C, "A New Era in Flow Rate Measurement." This 32-page booklet discusses the advantages of the rotameter for measuring flow rates, and, in addition to many diagrams and halftones, its pages are enlivened by humorous drawings contrasting the rotameter with other measuring methods.

Instruments and Controllers

A handsome new booklet (Bulletin 45-713) has just been released by the Hays Corporation entitled "Hays Instruments and Controllers in Industry." It features schematic drawings of typical applications of instruments and controllers to the following industrial control problems: pressure reducing, pressure relief or back pressure, rate of flow, turbine-driven compressor control, and control of speed, liquid level and liquid density. The various instruments and controllers applicable to these problems are illustrated and described in detail.

Oil-Bath Air Cleaners

The Vortox Company has recently issued new catalogs on their Types G & GA and Types S & SA Triple Action Air Cleaners. Besides detailed specifications and dimensions on all models and accessories, the catalogs contain full data on selection of the proper size cleaner for any internal combustion engine or air compressor. Illustrations and diagrams covering design, operation and construction and organized in an attractive layout make these new catalogs easy to use.

Spring Hangers and Vibration Eliminators

Blaw-Knox Company has published an attractive and colorful catalog (No. 2026) entitled "Blaw-Knox Functional Spring Hangers and Vibration Eliminators." This 36-page booklet graphically illustrates the thermal expansion of a piping system and how functional hangers permit the installation of economical shaped structures that allow free flexure of entire piping system in all plans. Many details are given concerning standard and special types and sizes of functional spring hangers and vibration eliminators; also instructions for their installation, and engineering data which will be helpful when adoption of this type of support is under consideration.

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